VDOT We Keep Virginia Moving

Regional Payment Systems Partnership

Action Plan

September 25, 2000

Volpe National Transportation Systems Center

In association with:

MULTISYSTEMS

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1 Introduction

Advanced electronic payment system technologies are creating new business opportunities for transportation service providers to partner and develop a truly "seamless" regional transportation network for their customers. The ability to use a single payment mechanism or a single "transportation" account within a regional transportation network provides users with an enhanced level of convenience and improved access to transportation services in comparison with traditional forms of payment.

Electronic payment media, particularly smart cards, can be linked to other non-transportation payment applications, linking transit, toll and parking payments, with corporate and university programs, human service benefits delivery programs, retail, phone and e-commerce programs. The creation of multiple application smart card programs can serve to further enhance the convenience of transportation while generating potential cost savings and/or increased revenue opportunities for participating public and private sector partners.

The Regional Payment Systems Partnership project had its beginnings in inter-agency discussions within the Electronic Payment Systems Working Group (part of the ITS Technical Task Force within the Metropolitan Washington Council of Governments). The study was contracted through the Virginia Department of Transportation (VDOT) and is being managed by the Northern Virginia Transportation Commission (NVTC).

The purpose of this study is to complement other electronic payments systems efforts in the region by:

- Engaging a wide range of potential stakeholders through a sequence of interviews.
- Identifying a longer-term vision for a multi-modal, and multiple agency system.
- Proposing a practical action plan that builds on the current programs and accomplishments.

Related regional efforts that this study is intended to complement and support include:

- The recent deployment by the Washington Metropolitan Area Transit Authority (WMATA) of the SmarTrip smart card system for Metrorail and parking.
- The current WMATA procurement of Metrobus fareboxes that will support Metrorail magnetic and smart card fare media, including options for the purchase of similar equipment by other local bus agencies in the region.
- The current Virginia Railway Express (VRE) procurement for fare collection system enhancements, which may incorporate a magnetic stripe or smart card and for which interoperability with other existing or planned fare collection systems including WMATA could be developed.
- The joint effort by several regional transportation agencies in 1999 to submit the SmartAccess proposal to the Federal Transit Administration, for a regional system to enhance multimodal payments integration.

- The Dulles Corridor Rapid Transit Project Technology Implementation Plan completed by the Dulles Corridor Task Force in late 1999.
- Current deployment of Amtrak system enhancements for the Northeast Corridor services that may include a smart card demonstration.
- An application for access to a portion of the federal funding allocated to the region for Intelligent Transportation Systems (ITS) deployment in Fiscal Year 2000.
- A commitment by the Virginia Department of Rail and Public Transportation (VDRPT) to provide funding to equip VRE and all local bus systems in Northern Virginia with fare collection equipment that supports interoperability with the WMATA advanced fare collection system. This commitment extends to establishing a clearinghouse for smart card payment transactions of the region's transit, toll and parking agencies.

The Washington, DC region has an extensive public transit network, with the Metrorail/Metrobus system and the VRE and MARC commuter rail lines as the central focus. A diverse array of smaller local and intercity bus operations complement these central services with extensive feeder connections to stations. Payments for parking and toll roads are also important, for transit users as well as those who commute using their vehicles alone. The extensive park and ride facilities at rail stations provide drivers with an ongoing choice between parking at a rail station and parking near their place of work.

A number of factors suggest that the time is right for seeking to develop a Washington, DC regional payment system. These include:

- **Successful introduction of electronic payment options in the region:** The strong customer interest in VDOT's Smart Tag and WMATA's SmarTrip programs have clearly demonstrated the potential of advanced technology to make transportation payments more convenient. Section 2.2 discusses these and other current revenue initiatives in the region in greater detail.
- **Growing emphasis on multiple agency coordination around the world:** The success of the regional multiple agency smart card fare program launched in Hong Kong in 1996 has led to a wave of similar regional programs around the world. In addition to major programs abroad (including Berlin, London, Paris, Rome and Singapore), several other regions in the United States (San Francisco and Seattle) are in the process of implementing similar programs.
- **Potential to connect the entire Northeast Corridor:** Transportation payments system enhancements are under development throughout the Northeast. Compatible electronic toll systems have already been established from Massachusetts to Delaware, and advanced payment systems have been implemented or are under consideration by Amtrak and by transit agencies throughout the Corridor. For instance, SEPTA in Philadelphia is studying possible fare collection system improvements, and several operators in southwestern Connecticut have begun to investigate the feasibility of developing an integrated payment system arrangement. The study team for this project recently completed a study that developed an action plan for collaboration on regional transportation payment systems in the New York City region. Advanced payment system technologies, including smart card technology has the power to knit the various transit

and toll systems together, promoting business and tourism through seamless corridor travel.

- **Opportunities to foster multiple application programs and establish new public-private partnerships:** Many types of organizations, including financial institutions, universities, retailers and telecommunications companies, are introducing smart cards. The creation of joint payment systems can make everyone's payment instruments more useful, while distributing program costs more broadly. Moreover, transit can be an important component of such a program, offering other entities the opportunity to quickly achieve extensive market penetration.

2 Context

Appendix A provides a glossary that defines acronyms and terminology used in this report. Appendix B lists the various regional reports or documents used as background material. Footnotes are also used throughout the report to reference specific sources for factual data.

In this report, we discuss a potential future payment system where a customer's payment instrument would be accepted for transportation payments throughout the region. The discussions about a future system involve no preconceived assumptions about which payment system technology is used, which agencies are accepting smart cards for fare payment, which agencies are issuing smart cards for regional use, which agencies may use other available technologies, or how a clearinghouse is operated. Most of these issues have yet to be resolved, and will be critical factors in the development and success of a regional, multimodal electronic payments system.

In addition to regional smart card acceptance for transit, this report also considers the integration of other types of transportation and non-transportation payment applications. One of the challenges that lies ahead is the potential integration of toll collection applications. Most major toll agencies in North America have implemented (or are in the process of implementing) an electronic toll collection system based on windshield-mounted radio frequency transponders, the Washington region is no exception. A transponder transaction is completed at a much greater distance from the reader than with a contactless smart card and operates in an entirely different frequency range. Regional smart card acceptance through transponders would require upgrading to newer and more expensive transponder equipment, where the smart card is actually inserted into a slot in the body of the transponder. There would also be integration requirements affecting the central system software. To many toll agencies, it is not yet clear whether the benefits of such multimodal integration will outweigh the costs, and this report considers steps as part of the action plan to help address and resolve these issues.

Matters specific to toll collection are addressed in detail at various places throughout the report. See in particular:

- Section 4.3.2.1, providing an overview of an integrated system for regional transportation payments. This section places the Smart Tag system in the context of the other transportation electronic payment system initiatives in the region.
- Section 7.1.3 details the issues and challenges of multimodal integration. For toll roads, this section discusses the need for smart cards to be integrated with transponders to enable integration with regional smart card based electronic payment systems for transportation. This will involve collaboration with Mark IV as the transponder vendor, as well as with the systems integrator for the central system. The recent introduction of a smart card accepting transponder developed by Mark IV is relevant, as is the upcoming need to renew Smart Tag transponders as the batteries wear out. This section also includes a look forward at some emerging developments that are expected to have an impact on regional toll payment systems in the medium term, including the new dedicated ITS spectrum and the medium-range "Bluetooth" wireless devices.

- Section 7.2.1 examines the issue of potential motivating factors for Smart Tag participation in a regional smart card system.
- Section 9.2.2 recommends an implementation strategy for linking with non-transit electronic payment systems in the region. These recommendations include
  - Further market research to quantify the extent to which smart card acceptance through transponders would benefit Smart Tag facilities.
  - Pursuing the benefits expected from implementing a system like that described in the Smart Access proposal.
  - Even if smart card integration is developed for Smart Tag, retaining a separate prepaid account capability to support Smart Tag facilities that are outside the Northern Virginia region.

As part of this study, exploratory interviews were conducted with a wide range of stakeholders. Although it was not feasible to meet with every potential stakeholder, a diverse and representative distribution was achieved as shown in the following table (Appendix C provides a specific list of interviewees and dates):

State and Regional	Transit	Toll Roads	Parking	Taxi, Paratransit and Airport Ground Transportation
• Metropolitan Washington Council of Governments • Virginia Department of Transportation • Virginia Department of Rail and Public Transportation • Maryland Mass Transit Administration • Northern Virginia Transportation Commission	• Washington Metropolitan Area Transit Authority • MARC • Virginia Railway Express • Montgomery County Ride On • Fairfax Connector • Arlington Transit • Alexandria DASH	• Dulles Toll Road • Dulles Greenway • Smart Tag Operations	• Arlington County Parking • Park and Ride Operations for WMATA, VRE and Dulles Toll Road • DC Parking (Lockheed Martin) • Metropolitan Washington Airports Authority • Washington Parking Association	• Arlington Transit • Alexandria Yellow Cab / Diamond Transportation • Metropolitan Washington Airports Authority

2.1 Regional Electronic Payment Systems Coordination

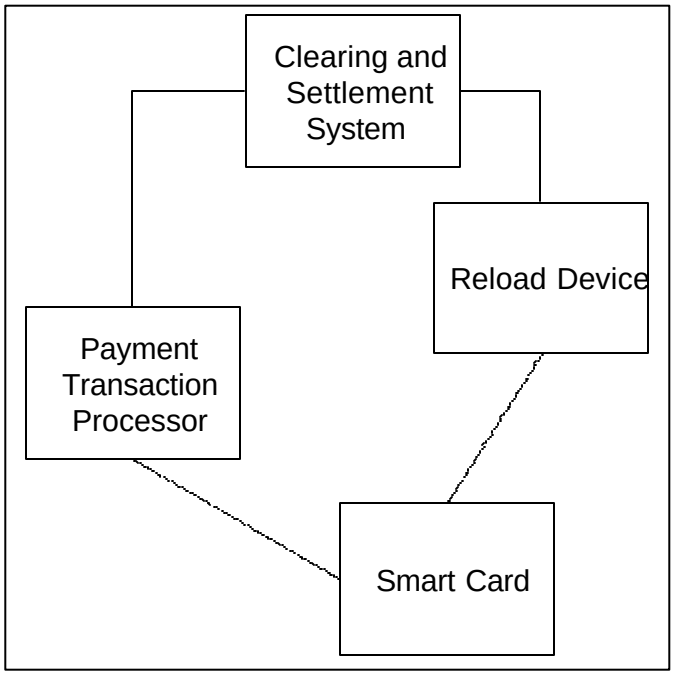
2.1.1 General Concept

Electronic payment systems use advanced fare media such as smart cards or magnetic stripe tickets:

- Electronically readable fare cards contain data representing prepaid fare value. The fare cards may be either disposable (discarded once the original value has been depleted) or reusable (customers can purchase additional value and have it loaded onto their current fare card).

- Readers at fare payment locations initiate communications with the fare cards presented by customers. These readers are electronic devices that review/adjust the card fare media data and store a fare transaction record in their own memory. This data is periodically transmitted to a central revenue management system.
- Smart cards are plastic cards with an embedded computer chip that complete transactions with readers by being either inserted ("contact") or brought within close range ("contactless"). Contact insertion creates a direct electrical connection inside a slot with metal contacts on the outside of the card. Contactless cards use short-range radio communications
- Magnetic stripe based systems operate in a similar manner. The stripes can be placed on either paper or plastic tickets and must be inserted into or swiped through the reader in a similar manner to conventional credit or debit cards.

Figure 1: Generalized Electronic Payment System



These types of fare media can carry stored value balance data as well as additional data that can emulate conventional prepaid fare media such as tokens, tickets and passes. Using advanced fare media can address certain shortcomings of conventional fare media. For example, advanced fare media can be used with automated fare collection equipment, and their data can be periodically updated to reduce the need for distributing physical fare media to outlets.

Ideally, each agency's fare cards could be used with all of the transit agencies in a region. Achieving this interoperability will require coordinated system implementation between agencies. Regional fare system interoperability is a key tool for improving regional mobility, as well as improving the range and accuracy of planning data. However, the clearing and settlement system required for interoperability between multiple transit agencies (and other

applications) will introduce new capital and operating costs relative to operations restricted to a single agency.

The main differences between magnetic stripe and smart card technology are:

- Smart cards carry more data, making it easier to carry enough to support fare payment with multiple agencies or to carry additional data for non-transit applications.
- Only the smart card can offer the short-range contactless wireless communications interface that improves passenger throughput, for bus and faregate operations, and reduces wear and tear on the readers.
- It is more difficult to alter data in a smart card chip, or to duplicate that data on another chip. To enhance security for a magnetic stripe card based system, the reader needs to be able to verify the card data through being on-line with the central system.
- Smart cards are more expensive individually, but can be reused over several years.
- Readers for contactless smart cards are solid state devices that cost less to purchase and maintain. Magnetic stripe card readers have electro-mechanical transports, so there are moving parts and slots to clean. For example, in the Hong Kong system discussed in further detail below, most of the faregate transactions have switched from magnetic stripe to contactless smart card and faregate maintenance costs are down 30%-40%.[1]

The diagram shows the general structure of an electronic transit fare collection system, where the fare media are used by customers to complete transactions with a variety of reload and payment devices. These devices may alter the data on the fare media, and in any case create transaction records that are used by a central computer system to reconcile fare media use, generate reports, etc.

Considering the rapid throughput requirements of bus and faregate operations, the use of contactless interface for transit fare payment is generally accepted as essential. The main exception may be for smart card fare transactions at Ticket Vending Machines, where a contact interface is feasible. Dual interface smart card technology has emerged in recent years, incorporating both contact and contactless interfaces (connected to a single chip so that a card application can use either of the interfaces). This technology will be useful if regional cards must support some uses for which the contact interface is preferred. Another role for a dual interface card may be to support adding transit use to a multiple application card that includes non-transit uses based on the contact interface.

Regional fare coordination implies that each agency's fare media can be used with multiple transit agencies in a region, meaning at a minimum that these agencies have installed devices that can read all of the participating agency fare cards. There is discussion later in the report about technical details associated with achieving the ability for readers to achieve interoperability with multiple agency cards.

It is not essential for the participating agencies to agree on common fare policies or a common fare structure, since the cards can support the equivalents of all the various individually preferred fare options. If there is interest among some or all of the agencies to collaborate on payments from a common pool of stored value, free or discount price

[1] Card Technology, May 2000

transfers, a joint loyalty program, etc., the cards and central system processes can be used to coordinate new policies and structures. The central system in this type of multi-agency program is typically referred to as the "clearinghouse" system.

Usually customer prepayments are collected by the operator of the central system and then distributed to the agencies through a periodic "settlement" process. If a customer buys the equivalent of an agency-specific fare option, the value would be transferred to this agency that day. If multiple agencies use a common stored value pool, funds would be distributed to the agencies based on the payment transactions submitted.

Current smart card based fare collection system initiatives include:

- **Hong Kong:** The "Octopus" system uses a contactless smart card, for fare payment from a common pool of stored value, with seven bus, rail and ferry operators in the region. It has been operating since 1997 and has become heavily used. As of April 2000, there have been over 6.2 million cards issued and the system performs over 4.2 million transit transactions per day (about 90% of all transit transactions)[2].

  The system is operated by a collective enterprise of the transit agencies, known as Creative Star. Although it was originally partially owned by the systems integrator, the transit agencies have since bought out the entire venture. Due to the large number of cards in circulation, deals have been arranged for the stored value to also be accepted by retailers and payphones near stations (for which Creative Star receives transaction fees).

- **London:** Implementation is underway for a comprehensive smart card based payment system for bus and subways, to be completed by 2002. The system will support London Underground and 5,800 buses operated by the 30 different Bus Operating Companies of London Transport Buses. The private sector consortium will supply the system and operate the entire revenue collection operation for 17 years, receiving up to $1.75 billion in fees contingent on meeting performance standards.[3]

- **San Francisco:** The regional Metropolitan Transportation Commission is managing the TransLink system implementation. The 26 individual agencies will use a common contactless card and a regional clearing and settlement system. A contract was awarded in 1999 will pay about $37 million for the smart card reader to be integrated with each agency's fare collection equipment. Although the vendor will own the central clearinghouse system (and might also use it to support transit systems outside the Bay Area), TransLink has contracted to use this system's services for a 10 year period on a fee-per-transaction basis. Depending on the transaction volume range achieved, annual transaction fees will total between about $8 million and $14 million[4]. The vendor is also proposing to use a dual interface card so that a multiple application system can be developed. The initial 6 month trial deployment is scheduled to begin by 2002, with six agencies (AC Transit, BART, the Caltrain commuter rail service, Golden Gate Transit, SF Muni, Santa Clara Valley TA) and about 5,000 cards.

- **Seattle:** Seven transit operators are combining to develop a regional contactless card system on a model that is conceptually quite similar to the TransLink initiative in San

[2] Passenger Transport, April 10, 2000.
[3] Collection Point (Cubic Transportation Systems publication), Fall 1998 and Summer 1999
[4] Discussion with ERG/Motorola representatives – June 1999

Francisco. Proposals were received in mid-1999 and evaluation is underway. A ballot initiative passed in late 1999 has severely cut general funding for transit agencies and this has resulted in a delay for a contract award until at least late in 2000 (implementation completion was originally planned for 2002).

2.1.2 Contactless Card Standards and Interoperability

2.1.2.1 Types of Cards and Standards

The contactless smart card systems implemented to date have utilized several types of contactless interface technology that are not compatible with each other (cards and readers from multiple vendors that use a different interface technology cannot communicate):

- Several contactless systems, beginning in the mid-1990's (primarily in Europe and Asia) have used the "Mifare" interface developed by Mikron, a subsidiary of Philips Semiconductors; the Mifare technology has been licensed to several smart card manufacturers. The Seoul and Pusan systems in Korea (implemented by Korean integrators Intec and KDE, respectively) use Mifare-based cards, as does the recently announced Freiburg, Germany regional system (implemented by US integrator Cubic Transportation Systems). Other examples include the Ajax and Burlington bus systems outside of Toronto (both implemented by Canadian integrator Precursor) and the Los Angeles Smart Shuttle neighborhood bus program (implemented by US integrator CDSNet).
- When Cubic Transportation Systems began marketing a smart card upgrade for its magnetic systems in the mid-1990's, it used its own proprietary "GO CARD." The SmarTrip system utilizes the latest version of Cubic's contactless communications interface.
- The Hong Kong Octopus system (implemented by Australian integrator ERG) cards were developed by Sony and represents yet another communications interface.
- Regional systems now under development (by a Motorola/ERG consortium) in San Francisco, Berlin, Rome and elsewhere will use Motorola cards based on a fourth communications interface. This interface is also being used in chips/cards developed by several other companies, including On Track Innovations (Israel) and ST Microelectronics (France). This type of card is now being used in several French systems, including Nice and Lyon (both implemented by Ascom), and will be used in the planned Paris regional system.

An effort to develop contactless card standards is now underway (International Standards Organization standard number 14443). The process has not been finalized, but at this point, Mifare and Motorola-type interfaces have been adopted as parallel standards (called Type A and Type B, respectively). The parallel standard means that although equipment from different vendors that is compliant with either the Type A or Type B portions of the standard should be compatible with each other, a combination of Type A and Type B equipment remains incompatible. The Cubic and Sony cards do not fall into either category, but there is a possibility that either or both could eventually be designated as "standards" (perhaps Type C and Type D) as well.

2.1.2.2 System Interoperability

For contactless smart card system components from different vendors (such as cards, readers or system software) to communicate with each other, several interfaces need to be interoperable:

- The "low-level" electrical details of the wireless communications link between cards and readers must be compatible (i.e., Type A or B, or, if using a proprietary interface, cards or other components must be from the same vendor).
- The software on the card chip needs to share a common command set and message formatting with the software in the reader, and these software applications must also have shared security codes.
- The software in card readers and revaluing devices must be able to complete data transfers with the central clearinghouse system.

Card readers with multiple low-level interface types are being introduced to address customer concerns about ensuring multiple sources for cards and accepting cards issued by others. For instance, Cubic's recently-announced "Tri-Reader" is capable of reading Type A, Type B and Cubic contactless cards. However, sharing a common low-level interface does not guarantee interoperability; as indicated above, software communications must also be compatible and there must be shared security data.

The key to integrated fare payment is the ability of each of the agencies in a regional program to accept cards issued by all participating agencies. Thus, it is essential that all agencies either 1) agree to procure the same system (i.e., from a single vendor) or 2) incorporate technical measures that ensure interoperability if agencies select systems from different vendors.

Agencies should adopt standard command sets, message formatting and security codes for data exchange with the clearinghouse. If agencies select incompatible card technologies, potential technical measures to achieve interoperability between cards and readers would include:

- One of the cards being changed to use a compatible interface to the other.
- Two smart card readers in the fare collection equipment, to accept both types of card.
- Use of a dual interface card reader.
- Arranging for the two card programs to be combined into a single card.

2.1.3 Benefits

2.1.3.1 Increasing Customer Convenience

Fare cards that can be used with agencies throughout the region would help address some perceived limitations to using transit (especially when customers are unfamiliar with the system). These limitations include the wide ranging fare options and fare media involved with the different agencies, and often with even the different services of each agency. It will be much more convenient to get one of the reusable cards that work with all the region's

transit agencies, than to periodically acquire a range of different passes, tickets, etc. Even if the card needs to be periodically updated to carry the electronic equivalents of the same set of fare media, at least the cardholder will be able to acquire media through a shared revaluing infrastructure. Additionally, cash customers can avoid the problem of needing exact change.

A smart card based system could keep track of transit usage over a certain time period and automatically provide discounts equivalent to various prepaid fare media. For example, all rides past a certain number in a month could be free, or the discounts could be set to a "sliding scale" stored in the reader (i.e. 1-10 rides at 100% fare, 11-20 rides at 80% fare, 21-60 rides at 50% fare, rides 61 and beyond free). In this approach, all payments are made from stored value eliminating the need to store the equivalents of any prepaid fare products on the card. It is possible that some agencies in a region could adopt such a stored value discount based policy (the specific discounting formula could vary), while others could retain the card equivalents of their conventional prepaid fare media. More information on the "Fair Fares" program being planned by WMATA is provided later in the report.

Current arrangements for providing free transfers or linked trip discounts, and also arrangements for loyalty or incentives programs, involve issuing paper transfers and punch tickets. Regional cards will provide a much more convenient method for providing these types of capabilities.

2.1.3.2 Improve Operational Efficiency

There are various ways in which electronic payment systems can streamline operations and improve efficiency:

- With a contactless smart card interface, a fare card can stay in the wallet or purse. The transaction is completed in well under a second, enhancing throughput and reducing dwell time.
- Driver safety is increased by having less cash on board the vehicle as well as by reducing the potential for fare disputes with boarding passengers.
- More consistent ridership data is available (if the on board system is linked with vehicle position or automatic passenger counting data, the value of the data increases further).

For the most part, this category of benefits applies more directly and strongly to farebox and faregate operations. As will be discussed in more detail later in the report, the use of smart card technology introduces some issues for onboard inspection operations such as are common in commuter rail or light rail.

2.1.3.3 Reduce Costs

Smart card systems, whether for a single agency or for several in a region, introduce a new type of operating cost. However, these systems can at the same time also provide savings in some conventional operating cost categories. When considered as an overall process that gets the money from the fare collection equipment into the bank account, cash handling comprises a significant portion of fare collection system operating expenses. There can also be savings through reducing the usage level of (and therefore the required maintenance for) coin/bill acceptance equipment, the amount of ongoing fare media distribution required and

the reliance on high-maintenance magnetic stripe card readers. For those agencies that are already cashless, there may be limited opportunities to reduce costs.

There are many shared capital and operating costs for a joint electronic transportation payments system, in particular for:

- Fare media distribution and reload
- Revenue management system
- Customer service and marketing

These are examples of functions where, with a jointly operated regional clearinghouse, individual agencies could be willing to transfer most of their capability to a shared system, with a residual system retained at the agency level which is more limited in size and scope.

The costs to an individual agency for their share of regional clearinghouse capabilities will be new operating costs. The opportunity is that the economies of scale and competitive procurement could combine to make the cost for their share of the joint system operation (combined with the operating cost of the residual system at the agency level) lower than for an operation kept entirely at the agency level.

It is not assured that a regional payment system will lead to a net operating cost savings. Implementing a regional payment system will require capital expenditures. Regions need to decide to proceed with a regional approach primarily on the basis of providing enhanced customer convenience and improved operational efficiency.

2.1.4 Opportunities

2.1.4.1 Start Creating the Regional Vision

Individual agencies in the Washington region have had success with integrating electronic payment systems. The most significant examples are the VDOT Smart Tag and WMATA SmarTrip programs (see section 2.2 for further information about these programs). Each of these has been embraced by customers and enabled the use of common payment mechanisms for separate services. The genesis of these success stories was with the development of a longer-term vision.

By working together at a regional level to build on the spirit of these initiatives, agencies can expect to eventually see the initial successes of these programs magnified and made more broadly available. A regional payment system program will create opportunities for the introduction of new fare policies and incentive programs.

Substantial progress has been made already in collaboration on developing a regional payments system. In June 1999, a simplified regional fare structure was implemented. WMATA and MTA have also collaborated with other local transportation service providers in developing the current farebox procurement.

2.1.4.2 Explore Partnerships

Regional payment system programs can take various forms and involve complex business arrangements. In the DC region, many transit agencies are participating in the Fare

Technology Working Group. This group is developing the concept and requirements for establishing a regional clearinghouse. As of July 2000, this group includes:

- Annapolis Transit
- Arlington Transit
- Corridor Transportation
- CUE Bus
- DASH
- Fairfax Connector
- Frederick Transit
- Harford County Transit Services
- Howard County Area Transportation
- Maryland Mass Transit Administration
- Montgomery County - Ride On
- Potomac and Rappahannock Transportation Commission
- Prince George's County - The BUS
- Virginia Railway Express
- Washington Metropolitan Area Transit Authority

WMATA has also been exploring partnering arrangements with several non-transit organizations that are developing (or considering) smart card based applications. These include:

- Amtrak
- Federal government General Services Administration
- First Union Bank
- Lockheed Martin IMS (toll road and parking payment systems).
- Metropolitan Washington Airports Authority (MWAA)
- Virginia Department of Transportation

2.1.5 Potential Participants

For the purposes of this study, the Washington metropolitan region has been defined to correspond with the boundaries of the Metropolitan Washington Council of Governments (MWCOG), encompassing the following jurisdictions (includes independent cities within the bounded area):

- District of Columbia

- Virginia:
  - Arlington County
  - Fairfax County
  - Loudoun County
  - Prince William County
  - City of Alexandria
  - City of Fairfax
  - City of Falls Church
  - City of Manassas
  - City of Manassas Park
- Maryland:
  - Frederick County
  - Montgomery County
  - Prince George's County

The study also examines issues and opportunities involving a broader region extending from Richmond to New York City, as well as related non-transit and non-transportation payment applications.

Major state and regional jurisdictions involved with transit in the study region include:

- **MWCOG:** MWCOG is the regional planning organization for Metropolitan Washington. A separate board at MWCOG, the National Capital Region Transportation Planning Board (TPB), is the officially designated Metropolitan Planning Organization (MPO) for the region. TPB has defined responsibilities under federal legislation for the inter-jurisdictional coordination of planning, as well as for the region's official long-range transportation plan and annual program.

  As a primarily consensus-building organization, MWCOG and the TPB operate to a large degree through standing committees. The TPB's Intelligent Transportation Systems (ITS) Policy and Technical Task Forces help coordinate regional activity on ITS planning and programming in the region. The ITS Technical Task Force has a number of subcommittee working groups on technical topics of focus. Advanced fare collection systems are addressed through an Electronic Payment Systems Working Group. This task force and other working groups provide a forum for regional discussions on ITS topics.

  In October 1998, the TPB adopted a vision statement, and goals and objectives that reference the need for a regional electronic payments system:

  > *"Establish a unified, technology-based method of payment for all transit fares, public parking fees and toll roads in the region." (Goal 4, Strategy 4)*

- **Virginia:** There are several state and regional transportation agencies that focus on transit within Northern Virginia. The Virginia Department of Rail and Public Transportation (VDRPT) coordinates linkages with local transit agencies throughout the state. The Northern Virginia Transportation Commission (NVTC) helps coordinate between the state and local agencies in the area (including Arlington, Fairfax and Loudoun counties as well as the cities of Alexandria, Falls Church and Fairfax). The Potomac and Rappahanock Transportation Commission (PRTC) has a similar role with the more outlying area that includes the Prince William and Stafford counties as well as the cities of Fredericksburg, Manassas and Manassas Park. As will be discussed in more detail later, these agencies are also involved with the management and operation of several transit operations.
- **Maryland:** The Maryland Mass Transit Administration (MTA) is an agency of the state Department of Transportation, operating bus, light rail, subway and commuter rail services. These services operate exclusively in the Baltimore region, except the intercity bus and commuter rail. Outside the Baltimore region, MTA is responsible for coordinating linkages between the state and local transit agencies.

2.1.5.1 Within Transit Community

The transit community within the Washington metropolitan region is beginning to work together to create the basis for a regional coordinated electronic payments system. The Fare Technology Working Group involves most regional transit agencies and is building on the early efforts towards regional fare simplification, to consider payment that can be used throughout the region, as well as establishing new fare policies and a regional clearinghouse.

Longer-distance trips often require transit customers in the region to deal with multiple transit services. The need to use a variety of different fare media is a disincentive for some potential transit riders. Transit agencies would also benefit from being better able to offer price incentives for use frequency, linked trips and prepayment. Even with the recent regional fare simplification efforts and the introduction of the "Fair Fares" program by WMATA the fare policies and structures in the region remain diverse and complex.

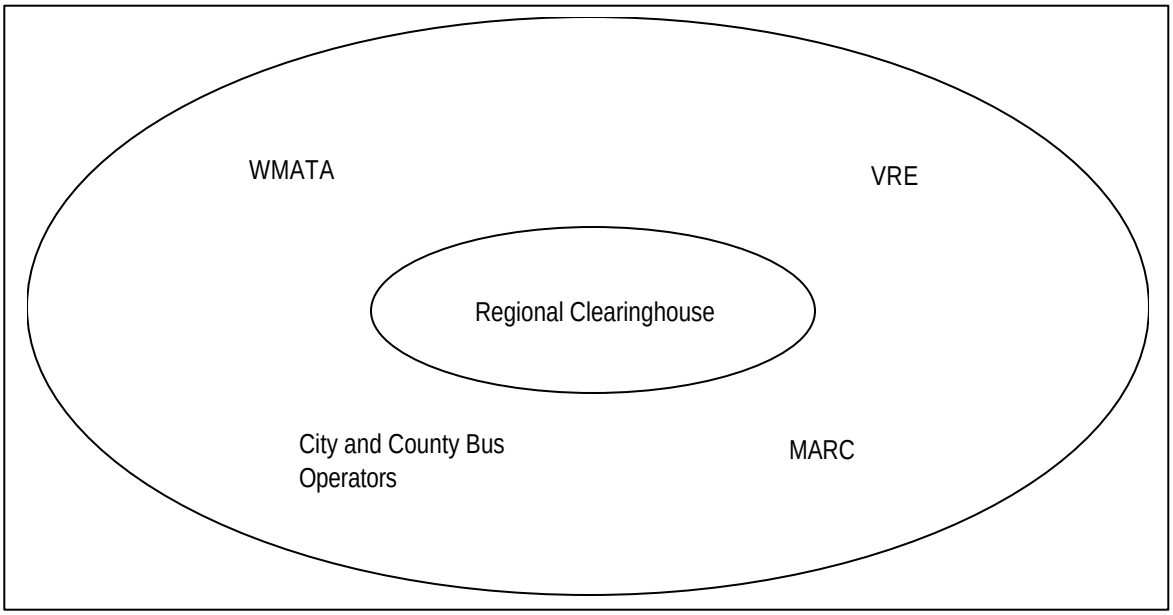
Other regional transit providers in the study are noted briefly below, detailed information about their operations and current fare systems and related initiatives are provided in section 2.2.

WMATA is the most central transit agency, and the most critical on a regional scale. WMATA is an independent body created by an interstate compact and jointly governed by the jurisdictions in its service area. It provides both Metrorail and Metrobus services:

- **Metrorail:** Five interconnecting heavy rail lines cross through the District and Arlington County, and connect with points in Alexandria, Fairfax County, Montgomery County and Prince George's County. WMATA is nearing the completion of the original 103-mile Metrorail system.

- **Metrobus:** The bus system operates throughout the defined region, except for the more outlying Frederick and Prince William Counties, including extensive connections with Metrorail stations. Within these regions, several individual jurisdictions have replaced some Metrobus services with alternative local bus services considered more cost-effective and which could provide supplementary routes for local priorities. In other cases, Metrobus operates some services for other agencies under contract.

Figure 2: Regional Transit Electronic Payment System



The following table summarizes the general magnitude of WMATA transit services:

Agency	1998 Annual Unlinked Trips (in millions)	1998 Annual Revenue-Miles (in millions)
WMATA Metrorail	213.0	44.8
WMATA Metrobus	126.0	33.2
Total	*339.0*	*78.0*

Source: National Transit Database
Note: Not including demand responsive services

The many other transit operations, although not carrying the same ridership levels as WMATA, serve a critical role in providing long-distance commuter services from outlying areas. They also provide services for suburbs that support local needs and act as feeder services for the Metrorail and other commuter services. These agencies include:

- **In Virginia:**
  - **Virginia Railway Express (VRE):** VRE is responsible for two commuter rail lines that connect Washington with the Manassas and Fredericksburg areas and stations in between. NVTC and PRTC jointly own VRE, since the stations serve both their jurisdictions.

- **Arlington Transit (ART):** Arlington County local bus routes.
- **Alexandria DASH:** City of Alexandria local bus routes.
- **Fairfax CUE:** City of Fairfax local bus routes.
- **Fairfax Connector:** Fairfax County bus routes.
- **PRTC OmniRide:** Commuter bus routes connecting Washington with Prince William County and other northern Virginia locations.
- **PRTC OmniLink:** Local bus routes and bus connections with VRE in Prince William County.
- **Loudoun County Commuter Service:** Commuter bus routes between Loudoun County and Washington.
- **Loudoun County Transportation Association:** Loudoun County bus routes.

- **In Maryland:**
  - **Maryland Rail Commuter (MARC):** Responsible for commuter rail lines connecting Washington with West Virginia and areas northeast of Baltimore along the I-95 corridor, operated by MTA.
  - **MTA Commuter Services:** Several intercity commuter buses connecting Washington with Prince George's, Montgomery and Frederick Counties are also administered by MTA.
  - **TransIT:** Frederick County bus routes
  - **Ride On:** Montgomery County routes.
  - **The BUS:** Prince George's County bus routes.

Transit services operating beyond the defined region, which Washington commuters may use for feeder connections with commuter services, have been excluded (such as the Maryland MTA services in Baltimore and several others including the local bus systems for Annapolis, Laurel, Howard County and Harford County).

The following table summarizes the general magnitude of several of the other large transit services (local bus agencies with annual ridership over 4 million and commuter rail):

Agency	1998 Annual Unlinked Trips (in millions)	1998 Annual Revenue-Miles (in millions)
Ride On	18.1	7.9
MARC	4.7	4.6
Fairfax Connector	4.7	3.5
VRE	1.9	1.0

Source: National Transit Database
Note: Not including demand responsive services

2.1.5.2 Within Regional Transportation Community

Many other transportation payments within the study area could also use the clearinghouse system. In addition to other types of public transportation, a regional transportation payments system could support toll roads and parking.

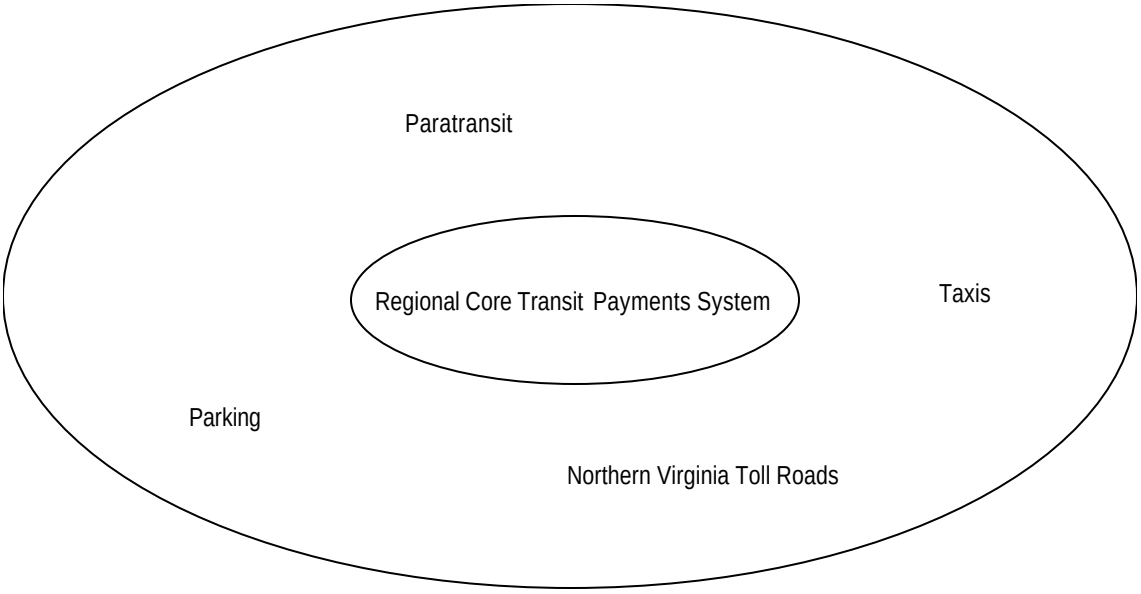
The overall system would still operate in a conceptually similar manner, with the smart cards paying for various types of transportation. The cards would combine one or more stored value pools, perhaps also carrying card equivalents for various agency-specific prepaid products. The smart card might need to operate through the transponders to enable integration with Smart Tag operations. These transponders are the electronic windshield mounted transceivers used by customers to enable electronic toll collection. Issues related to electronic toll collection and transponders will be discussed in greater detail later in the report.

The following are some types of transportation providers beyond fixed route transit that could participate in a regional electronic payments system (the specific providers involved will be discussed in section 2.2):

- **Other Public Transportation:**
  - **Paratransit:** This generally refers to several different types of transit that complement conventional fixed route service, encompassing both special services for seniors and the disabled as well as a variety of other complementary services for the general public. The Americans with Disabilities Act (ADA) requires a mandatory level of such service for customers who would have difficulty using conventional services, so most agencies participate in some paratransit arrangements. These arrangements vary from:
    - A service directly operated by the transit agency using dedicated vehicles, often with a supplementary role for local taxi services.
    - Outsourcing the service.
    - A "brokerage" (where the broker is a contractor that provides the services on behalf of the organizations responsible for providing paratransit, through arrangements with a variety of subcontracted providers, including taxis and others).
    - Subsidies for the use of private services such as taxis under certain circumstances.
  - **Taxis and Other Airport Ground Transportation:** Diverse private operations provide taxi services (this includes paratransit services and "for-hire" operations for the general public). Airport ground transportation refers primarily to dedicated airport taxi services, such as the Washington Flyer service at Dulles, and various door-to-door shuttle operations such as Supershuttle (because they collect a fee directly from the passenger), as opposed to courtesy vans for hotels, rental car centers and parking lots.
- **Northern Virginia Toll Roads:** VDOT originally developed the Smart Tag electronic toll collection system center for processing and customer service in 1996, for the

VDOT-operated Dulles Toll Road in Fairfax County. Smart Tag operations have been outsourced and are now used to also support the use of Smart Tag transponders with the privately owned Dulles Greenway, which extends the Dulles Toll Road into Loudoun County, and other Virginia Smart Tag facilities outside the study area.

Figure 3: Regional Transportation Electronic Payment System



- **Parking:**
  - **Airports:** Dulles and National airports each provide substantial parking facilities. The values of individual payments vary widely, from short-term to stays of a week or more.
  - **Park and Ride:** There are many Park and Ride facilities. The highest demand facilities, at Metrorail stations, are not free. Park and ride for commuter rail is generally free, to help build ridership. VDOT also operates free park and ride facilities to help enable carpooling and, in some cases, to access transit. There is an opportunity to require a premium price if the person parking does not connect with an adjacent transit service, by providing a rebate only if the card makes the transit connection.
  - **Municipal parking authorities:** Most cities in the region operate a municipal parking authority, with varying facilities such as on-street parking meters and off-street lots/structures. In the District, municipal parking operations have been outsourced to Lockheed Martin
  - **Commercial and institutional parking facility operators:** Every city has commercial parking operators, especially in their downtown areas. Many private or quasi-public institutional facilities also operate pay parking, such as universities, hospitals, airports and major employers.

2.1.5.3 Transportation Community Within the Southern I-95 Corridor

There are emerging opportunities to broaden the reach of an electronic transportation payments system to encompass the southern portions of the I-95 Corridor. This would generally encompass a "greater" Washington region (roughly extending to Richmond, into West Virginia and to Baltimore) and also father northeast along I-95 to New York City:

- Amtrak operates several inter-city rail lines that connect into Washington from the north, south and west. As Amtrak introduces high-speed rail, "corridor commuting" may become even more widespread.
- There is a general trend towards better connections between airports and local transit systems.
- Toll agencies in Maryland, West Virginia, Delaware, Pennsylvania, New Jersey, New York and Massachusetts have or are preparing to create electronic toll collection systems that will work towards the "one transponder, one account" vision of the E-ZPass Inter Agency Group. The IAG is a collective organization of these toll agencies, supporting interoperability between them, discussed in greater detail in section 2.2.

Regional groupings of transit agencies, parking, toll roads and airports include participants such as:

- In the "greater" Washington region beyond the study area – (1) Richmond region transit, parking and Smart Tag facilities and (2) Baltimore region subway, light rail, buses, parking, M-Tag electronic toll collection facilities, all operated by the Maryland Mass Transit Administration. As will be discussed more later, Maryland MTA is participating in the current procurement for SmarTrip-compatible fareboxes, together with WMATA and a range of transit agencies in the Washington region.
- In Philadelphia/Wilmington region – Southeastern Pennsylvania Transit Authority, Port Authority Transit Company, Delaware Transit Corporation, New Jersey Transit, parking, Pennsylvania Turnpike, Delaware River toll bridges and other Delaware toll facilities.
- In the New York/New Jersey region – New Jersey Transit, Port Authority of New York and New Jersey (PATH trains, bi-state toll facilities and airport parking/transit connections) and New Jersey and New York MTA (subway, commuter rail and toll facilities), New Jersey toll facilities and parking.

2.1.5.4 Beyond Transportation

Many types of non-transportation smart card based systems are also under consideration throughout the corridor, for both payment and other purposes. Emerging smart card technology, including card operating systems that support multiple applications as well as the ability for these applications to access both contact and contactless interfaces, will help enable joint use of a smart card based system to support many diverse applications. As will be discussed in greater detail in section 2.2.3.3 in relation partnering beyond transportation, proprietary card operating systems can support more than one application but the new breed of card-independent operating systems (MULTOS, Java Card and Windows for Smart Cards) help enable greater issuer flexibility.

This will increase the perceived customer value for the cards and allow the participants to share infrastructure and operating costs. There are other areas for exploring synergy as well, such as cross marketing through joint loyalty/incentive programs with retailers, making free parking contingent on the use of adjacent facilities, etc. Some examples of potential partners include:

- State programs, such as the Maryland smart card driver's license program
- Universities and employers, such as the plans by the Department of Defense and the General Services Administration to provide millions of federal government employees in the region with multiple application smart cards (more information on this initiative is provided later in the report).
- Sports and entertainment facilities
- Financial institutions, considering smart cards that would support credit/debit, "cash replacement" retail stored value purchases and storing digital certificates to facilitate Internet-based commerce
- Internet electronic commerce providers

Pairing transportation payments with non-transportation applications can also help to promote transit use with market segments that will be natural users of the non-transportation applications. As an example, being on the same card with applications of interest to university students may help to increase their use of transit.

It will be critical for transportation agencies to develop a comprehensive and well organized "transportation application", on a regional or even corridor-wide scale, as a precursor to pursuing effective negotiations with potential multiple application card partners as a significant participant. Potential partners in areas such as the financial sector generally see transportation as a promising payment sector with which to pursue a synergistic approach. However, they also perceive that individual agencies are generally fragmented and should complete a lot of preliminary work to decide "what they want" as a group out of participation in a multiple application smart card system.

2.2 Current Revenue Initiatives and Opportunities for Enhancements

2.2.1 Core Regional Transit

2.2.1.1 WMATA

The current Metrorail fare collection system was installed by Cubic when the rail system was created in the 1970's. It is an early generation of electronic fare payment technology using magnetic stripe stored value paper tickets to support the policies that determine the Metrorail fare based on both the distance traveled and the time of day. Faregate transactions are required on entering and exiting rail stations. The initial transaction stores the entry station on the ticket so that the correct fare can be deducted at the exit station.

Customers purchase tickets at automated machines in stations outside the paid area, using the residual value on a previous ticket supplemented with a user-selected cash or credit card amount. Whenever at least $20 value is purchased on a ticket, a 10% bonus is added to the stored value. After each payment transaction, the revised stored value balance is printed on the ticket. If the balance is insufficient for the exit transaction, customers must pay the missing amount at one of the additional automated machines near an exit faregate before the ticket can be used to exit.

There are no current plans to eliminate the magnetic stripe tickets. Part of the reasoning is that, however successful SmarTrip might become, Washington will continue to have a sizable contingent of customers who use the system on only a short-term basis (such as tourists and business travelers).

2.2.1.1.1 SmarTrip

WMATA offers a smart card fare media option (SmarTrip) throughout their rail and parking operations (deployment began in May 1999) that supplements the magstripe tickets. There are a total of about 1600 card readers. SmarTrip passed the milestone of 100,000 cards issued in September 2000, over 30% of the rider base. More than 20% of all Metrorail trips are made using SmarTrip. The system vendor is Cubic, as with the current WMATA Metrorail fare system, the MetroCard system at New York City Transit and the TransitCard system at the Chicago Transit Authority (all magnetic stripe ticket based systems).

The new system continues to support the same fare policies, but there are several performance enhancements and capabilities that are enabled. These include faster throughput at the faregates and the fact that the cards are revalued indefinitely (since there is no printing onto the card). The magnetic tickets were also prone to becoming demagnetized. Cardholders have the option to register their card with the agency. This policy allows the cardholder have the balance restored on the card if it is lost or stolen (the balance from the central system, as of the last recorded transaction). This policy allows people to feel more comfortable with carrying a larger balance on the card (WMATA policy limits the balance to a maximum of $200).

Currently, expansion of WMATA smart card acceptance to Metrobus is under development. In addition, other regional transit operators are considering accepting the WMATA smart card, such as commuter rail (VRE and MARC), Baltimore region transit (Maryland MTA) and local bus agencies. Some agencies may chose to supplement their existing fare systems with SmarTrip while others may use SmarTrip as their primary payment media. A joint procurement was initiated by WMATA and Maryland MTA in March 2000 (deployment is scheduled for completion during 2002), for new fareboxes that will enable the use of the rail fare media on buses. These fareboxes may be procured to support magnetic stripe card readers, or smart card readers, or both.

Through this procurement, local bus agencies will have the option to purchase the fareboxes selected by WMATA and MTA, including the option to support smart card acceptance (some agencies may exercise an alternate option to purchase a stand-alone smart card reader). Passengers would be able to use the same farecard with Metrobus and Metrorail. WMATA has created the possibility, through the farebox procurement, that the fareboxes supplier might retrofit the existing rail faregates and parking fare collection equipment with a new and different technology from that currently in use with the SmarTrip system.

WMATA is also exploring non-transit partnerships, including:

- The General Services Administration (GSA) selected five consortia of pre-qualified vendors in May 2000. Individual federal government agencies would use the services and technology available from these consortia to deploy employee smart cards, which will be discussed in additional detail at a later section about non-transportation initiatives. A related one-year joint trial with WMATA, involving federal government employees of the Department of Education, began in August of 2000. These employees would be provided with a two chip dual interface card that can serve as a SmarTrip card while also providing a variety of employer applications (these include building access, medical emergency information, property pass authorization and events attendance).
- Another one-year trial for a private sector partnership with WMATA began in March 2000. First Union Bank have selected about 700 of their customers to receive a contactless only card that can serve as a SmarTrip card (while also carrying their First Union ATM card magnetic stripe). The main benefit to these customers is to save wallet space by combining two cards into one. When increasing SmarTrip the stored value balance by making a prepayment with a debit card transaction, the card must be swiped in the same manner as any other bankcard to complete the debit card transaction.

2.2.1.1.2 Metrochek

Current federal law permits employers to provide a transit subsidy benefit of $65 per month to each employee. Starting in January 2002, this subsidy will increase to $100. A presidential Executive Order issued in April 2000 requires that all federal agencies offer the transit subsidy benefit to their employees at the maximum allowable level by October 2000. Employers can provide transit fare media to employees each month for free, or the employer can let the employee pay for these from pre-tax income. In addition, legislation recently passed in Maryland will permit employers offering free transit passes to garner additional tax credits, at 50% of the employers cost up to a maximum of $30 per employee per month.

Transit agencies have a variety of different fare media for employees to choose from, however, the logistics of allowing employees to make these choices from month to month is labor intensive for employers to administrate. Employers prefer voucher programs, which can be redeemed by employees for the fare media of their choice, any unused vouchers can be carried forward and used in the following month. Employees also prefer vouchers, which are more flexible than the direct distribution of fare media (since they allow employees to readily purchase fare media, such as a monthly pass, that might cost more than the amount of the benefit with the employee paying the difference).

In response to these requirements, WMATA developed the Metrochek program. There are similar programs at other agencies nationwide (such as TransitChek in the New York City region and TransitPlus in the Baltimore region). Employers purchase the Metrochek vouchers in bulk. Employees can use them directly as WMATA Metrorail fare cards or use the vouchers towards the purchase of prepaid fare products with WMATA or most other local transit agencies. Metrocheks accepted by other agencies are later redeemed with WMATA, but only if the Metrochek has not been used at all (WMATA will not refund any portion of a partially used Metrochek). Metrocheks use a magnetic stripe that can help those who accept Metrocheks to assess their validity.

Current tax law can allow employers to provide the benefit as cash instead of vouchers (in which case there is no assurance the employee will be use it for transit) if the voucher program is not "readily available". The Internal Revenue Service is considering a change to the law that would define "readily available" more concretely as meaning that the vouchers cannot cost the employer more than 1% of their value. Conventional paper-based voucher systems are difficult to operate this inexpensively.[5]

To reduce administrative costs and attract employers to use the Metrochek program, WMATA is considering Metrochek distribution to employees electronically using the SmarTrip system. Referred to as the SmartBenefits program, employers would use a computer interface through the World Wide Web to notify WMATA of the Metrochek amount to be downloaded to each of their employee's cards. By sending this information out to all the revaluing vendors in the system at the beginning of the month, electronic Metrocheks can then be created in the smart cards. A flag must also be set in the card so that it cannot be used to collect the benefit repeatedly at different machines.

As part of this approach, all Metrochek acceptors would need to be equipped to read them from the SmarTrip cards. This could be challenging to achieve universally for the full range of transit services currently accepting Metrochek. There is also the fact that requiring an employee to get a smart card to participate in Metrochek could be a barrier to some. Potential complementary measures could include keeping some paper Metrocheks available for employer distribution and providing convenient locations to redeem some of the smart card based Metrocheks for the paper form.

2.2.1.1.3 SmarTrip Expansion

Fare simplification was an initial effort towards establishing a regional transit fare system. The differences in fare policy between the region's transit agencies were felt to be limiting the potential to increase the overall regional market share for transit. WMATA has worked with the local bus operators to develop a common approach for reducing the differences in general fare structure and transfer policies. Fare simplification moved into the implementation phase for Metrorail, Metrobus and local bus agencies beginning in June 1999. The measures include:

- The elimination of all fare zones, to establish a single regional Metrobus fare.
- Free bus-to-bus transfers, with equitable "step-up" fares where one agency's fare is higher than another's.
- Universal bus acceptance of transfers from Metrorail and a common rail-to-bus transfer discount.
- A regional bus day pass
- Universal bus acceptance of commuter rail and Metrobus passes

The main issues remaining beyond the simplified fare regime implemented to date seem to be related to equitably sharing revenues. There is a rail-to-bus transfer discount for which the bus agencies get no compensating share of the Metrorail revenue, but no corresponding

[5] Passenger Transport, June 12, 2000

bus-to-rail discount. To address these issues, acceptance of a customer's card throughout all the operators is needed.

In parallel with SmarTrip introduction for rail and parking, WMATA has been preparing for Metrobus to accept their smart card. There is also interest in extending acceptance of the WMATA smart card for broader regional transit use, to include other bus agencies and commuter rail. Many agencies have already begun participating in the Regional Fare Technology Working Group. This group hopes to address issues related to regional payment system coordination as well as developing requirements for the establishment of a regional clearinghouse.

The Regional Fare Technology Group is currently attempting to build consensus between regional transit agencies and to discuss alternative operational concepts for a multiple agency system. WMATA is currently procuring new Metrobus fareboxes that will accept common magnetic and smart card fare media with Metrorail (not purchasing magnetic stripe card capability as part of this package is being considered). As will be discussed later in the report, Maryland MTA may purchase the same fareboxes through this procurement, supporting a different magnetic stripe card and perhaps a SmarTrip compatible smart card reader. These fareboxes would also support bill validation, so that a rider could pay the fare with a $5, $10 or $20 bill and have the change created as a revalue to their fare card.

As a result of the efforts of the working group, options are included in the procurement to allow local agencies to purchase the same equipment. The agencies would, within 180 days after the WMATA and MTA procurement, be able to purchase new fareboxes with integrated fare media readers (magnetic stripe and/or smart card). As an alternative, some agencies might purchase "stand-beside" smart card reader equipment (if they cannot justify the purchase of new fareboxes and can fit the separate readers onboard as distinctly housed equipment). With a group of agencies accepting a customer's single fare medium, there is the further need to establish a clearinghouse that would equitably distribute revenues based on actual usage.

The WMATA smart card might not carry the prepaid fare products that are unique to some other agencies that will accept the card. Those agencies would then need to decide whether to continue offering prepaid products in their conventional form, offer a smart card of their own or only accept payments from the WMATA smart card stored value. With all payments from stored value, an agency may need to establish a revised fare policy that maintains the established frequent user price incentives by determining the discount for each fare individually (based on the information about card use frequency stored in the card).

2.2.1.2 Commuter Rail

Two different operating concepts are commonly discussed for the potential use of magnetic stripe or smart card fare media on commuter rail. Commuter rail typically involves boarding from open platforms (where the ticket would be validated in a self-service operation) and requires onboard ticket inspection:

- **Inspect the Advanced Fare Media:** If a magnetic stripe ticket has the latest validation printed on it, it could be inspected in a traditional manner. A smart card would require the use of a small portable reader by the inspectors, and this can raise issues with the change in their work environment. For example, the portable unit to by used by Amtrak

conductors connects a lighter handheld unit (keypad, display and card reader) to a belt-mounted unit (printer, electronics, battery) to help address this issue. The Amtrak system is discussed further in a later section.

Another concern with this approach is that any particular card will not be read by the system on a predictable basis. This would limit the effectiveness of planning data collected through the system.

- **Use the Advanced Fare Media to Purchase a Conventional Paper Fare Instrument:** The purchased paper ticket could be a single-ride ticket. It could also be any of the multiple use fare instruments sold through conventional methods, such as a multiple ride ticket (which would need to be validated for each trip in the conventional manner) or a period pass. The paper ticket could then be inspected on-board directly and a portable smart card reader would not be needed.

2.2.1.2.1 MARC

Amtrak operates the northeast Maryland line, although MARC provides the crews. CSX operates the other two MARC lines. MARC pays operating fees, minus the collected fares (retained by the operators). Fare collection on all lines uses traditional railroad methods, involving tickets inspected onboard by a conductor (purchased from the conductor onboard or prior to boarding). These are not "proof of payment" operations since conductors inspect all tickets. Onboard purchase is important for customers without period passes since some stations are not equipped for advance ticket purchase.

Within the last few years, MARC has been responding to indications from the governor's office that MARC should take the initiative in implementing smart card technology for the state. Even without regional fare coordination, the use of smart card technology would lead to substantial improvements in the available ridership data.

There is a concern about the impact of onboard smart card inspection on conductor operations. Some stations are close together and conductors need to move quickly through the cars to inspect all new arrivals after each stop (some cars use a 3-2 seat configuration that places certain seats relatively far from the aisle). Rapid onboard ticket inspection is complicated by the continuing need to support onboard ticket purchases.

MARC has suggested the continued use of on-board visual inspection to the governor's office, with the role of the smart card being to enable the purchase of single trip tickets from a stored value purse (tickets would be purchased from self-service platform devices at stations without ticket office machines). The objective of this approach is to reduce the need for on-board ticket purchases that slow down conductor operations. However, the governor's office has indicated that more extensive use of smart technology is preferred and MARC is now leaning more towards the use of portable smart card inspection equipment for the conductors. MARC is considering a transition towards "proof of payment" type inspection (not comprehensive but random) in conjunction with this approach.

2.2.1.2.2 VRE

The VRE lines began service in 1992 and are operated by Amtrak under contract. From its inception, VRE has never accepted cash at stations or onboard. Customers can use either a

credit or debit card at platform Ticket Vending Machines to purchase fare media or customers can also purchase fare media by mail or at any participating retail outlets.

VRE has a procurement underway to enhance its existing fare collection system. Although retaining the no cash approach, it will also introduce new ticket issuing machines, an "honor system" for deferred cash payments and fare media purchases on account. A new VRE "frequent user" card (the "Club Card") may be implemented in conjunction with the account-based program, including loyalty features. A Club Card may use magnetic stripe or smart card technology, so that it could be read automatically at TVMs.

VRE may also choose to equip their TVMs to read WMATA SmarTrip cards. Accepting SmarTrip may offer several benefits to agencies like VRE:

- Using SmarTrip for VRE fares would be convenient for VRE riders who transfer to WMATA services. If the SmarTrip card becomes accepted throughout the region, the seamless passage offered between all the transit agencies could make transit use more attractive in general.
- There could be the opportunity to support accepting Metrocheks distributed on SmarTrip for fare purchases. The ability to accept Metrocheks carried on SmarTrip cards at their TVMs could be particularly useful for VRE, since there is no existing capability at the platforms that allows the use of Metrocheks for purchasing VRE fare media. VRE's Metrochek users must currently submit vouchers by mail, or exchange Metrocheks at one of the retail outlets that sell VRE fare media. Then, VRE staff must manually process and submit these Metrocheks to WMATA for reimbursement.

2.2.1.3 Local Bus

The local bus agencies were generally created in the 1980's in response to perceptions that Metrobus was not able to address the full range of local priorities for bus service. It was also felt that local service (in many cases outsourced to a private sector operator) could be more cost-effective. Within the various jurisdictions, Metrobus continues to operate certain routes (or operates routes at certain times of day), while also winning competitive contracts to operate some or all of the local routes themselves. Most routes that cross the jurisdictional boundaries are operated by Metrobus and these are referred to as "regional" routes. The locally operated routes substitute for former Metrobus routes and add new routes that supplement Metrobus service. There are some instances where local agencies and Metrobus effectively compete along higher volume Metrorail feeder routes.

Currently, all of these agencies accept cash fares and would likely continue to do so. For the most part these agencies have electronic registering fareboxes, some of which are older and ready for replacement, others of which are fairly new. Most have discounted prepaid fare media of varying types. One exception is Fairfax Connector, which generates more than enough ridership based on its low fare (50 cents on most routes) and has no need for incentives. As discussed earlier, under the current WMATA procurement the local bus agencies will have the option to purchase the same fareboxes selected for purchase by WMATA and/or MTA, including the option to support acceptance of a SmarTrip compatible smart card.

These agencies (together with the commuter rail operators) are generally in favor of regional fare simplification and integration efforts, including the concept of a customer's farecard being accepted by all agencies in the region and the idea of an equitable revenue distribution clearinghouse. Many agencies seem to appreciate the degree to which WMATA has been involving them in the fare simplification and joint farebox procurement efforts. The local agencies are, however, (1) concerned about moving too quickly to eliminate conventional prepaid fare products, (2) want to continue to retain fare policy autonomy and (3) want to address and resolve the revaluing process for bus-only riders. As an example of local fare policy autonomy, Ride On in Montgomery County announced in May 2000 that they would cut pass prices by over 40% and offer free fares to elementary and high school students on weekends from 2 PM to 7 PM[6].

2.2.1.4 Dulles Corridor Transit

The "Dulles Corridor" refers to the area running roughly northwestwards from Falls Church through Fairfax County and past Dulles Airport (into Loudoun County and towards Leesburg), generally paralleling the route of the Dulles Toll Road and the Dulles Greenway. It is experiencing ongoing rapid increases in population and employment and rapid transit options are under active development.

Plans have been developed to extend rail (which would be operated as an extension of the Metrorail system) from a Metrorail station in the vicinity of Falls Church to Tyson's Corner by 2006 and into Loudoun County by 2010. A sequence of increasingly higher capacity bus-based transit service options out of West Falls Church Station are planned for the interim period, beginning in the near-term with express buses and progressing (by 2003) to Bus Rapid Transit (BRT) service. BRT involves augmenting bus service with specific types of advanced technology and dedicated right of way to create intermediate capacity service approaching the capabilities of light rail.

Smart card based payments may have an important role in enabling rapid boarding, a key BRT operational concept, by supporting fare collection at stops prior to boarding while also reducing cash collection expenses from the far-flung stations. The Dulles Corridor Rapid Transit Project has a high state and regional priority, some funding and is building momentum. A report on the role of technology in the corridor plan has been completed, which features electronic payment. Coupled with the presence of electronic toll payment and parking facilities in the same corridor, the Dulles Corridor should be considered as an early deployment stage for a regional multimodal smart card based payment system.

2.2.2 Regional Transportation

2.2.2.1 Tolls

This section focuses on the Smart Tag electronic toll collection system, since there are Smart Tag facilities operating in the defined study area. There are also several M-Tag electronic toll collection facilities in the Baltimore region. These are discussed further in section 2.2.3.

[6] Passenger Transport, May 8, 2000

Dulles Toll Road and the Dulles Greenway use a common transponder and a common central system for transactions processing, known throughout Virginia as the Smart Tag system. An early addition to the Smart Tag system was the Coleman Bridge, a rural crossing to the Middle Peninsula. The Richmond region has additional Smart Tag facilities that opened in 1999.

Smart Tag systems operate with conventional toll plazas, booths and gates. In addition to having cashiers and facilities for cash toll collection, toll lanes are equipped with readers and antennas to complete transactions with the transponders as vehicles pass through. Although the Smart Tag operators are not members of the E-ZPass Interagency Group, they are using compatible technology (manufactured by Mark IV) and there is the potential for future collaboration. Dulles Toll Road ETC penetration is at about 50% of the 340,000 average daily transactions. The Greenway has about 40,000 average daily transactions, and offers a frequent user discount program that may contribute to a higher ETC penetration (about 70%) during peak periods. In an effort to increase Smart Tag use, Dulles Greenway recently increased the toll $0.25 for cash and credit card payments.

While there is considerable interest in increasing Smart Tag market penetration there are no specific initiatives currently underway at the Northern Virginia Smart Tag facilities. VDOT indicates they would like to see some evidence that a regional smart card based payments system could assist them in achieving this objective.

2.2.2.2 Parking

Parking operations in the Washington, DC region are diverse, involving many different public agencies, institutions and private sector companies.

- Meters are the mainstay of on street parking, with most meters operating exclusively on a cash basis. Cash collection and enforcement are labor-intensive, and the cash can be a theft target. Another difficulty with conventional parking meters is that some people intentionally jam coin slots (this can also occur with contact smart card slots) to take the meter out of commission and avoid the need to pay.
- Revenue systems for off street lots and structures make extensive use of various types of devices, including entry/exit tickets (barrier or pay-on-foot), pay-by-space (multi-space meters) and pay-display. Many longer-term parking facilities have begun to accept credit or debit cards. Public agencies and landowners (operating parking for their customers/employees) may be in a stronger position to invest in revenue system enhancements (that will provide savings in operations and maintenance costs) than commercial parking companies, who operate in a very fragmented and competitive industry.

2.2.2.2.1 DC TransPass

Lockheed Martin operates municipal parking in Washington, DC under contract to the DC Department of Public Works. A demonstration for integrating smart card technology is required, and is being referred to as TransPass. Although a start date has not yet been set, this trial implementation would last about 6-9 months, with about 2000 meters and about 10,000 cardholders. A privately owned off-street parking facility may also be included in the trial implementation.

TransPass is expected to use a card technology compatible with the currently installed smart card accepting onstreet Duncan meters. These meters are currently equipped with slots for contact interface cards. Lockheed Martin is discussing with WMATA and Cubic Transportation Systems the use of a contactless interface for the TransPass card, so the same card could be used for both SmarTrip and TransPass. In addition to the increased convenience for cardholders, contactless readers would involve less meter maintenance than the slots in contact readers, which tend to be jammed (as are coin slots) by some customers through a misunderstanding or to put the meter out of commission.

2.2.2.2.2 Airport Parking

The Metropolitan Washington Airports Authority (MWAA) indicates most of their parking users are relatively short-term (i.e. business) travelers, staying 2-3 days. MWAA accepts both cash and credit cards at the exit lanes. . MWAA is currently considering whether to use SmarTrip and Smart Tag (or perhaps both) to achieve faster throughput and alleviate queues at the main Dulles facility exits.

One issue is the higher infrastructure capital costs for transponder readers and overhead antennas, compared to smart card readers. MWAA may defer deployment until there is a regional consensus on electronic payments, and the relative roles of smart cards and transponders is better developed. An alternate approach would use SmarTrip as a payment method at pay-on-foot machines inside the terminals, coupled with express exit lanes for those who have prepaid at these machines (rather than directly equipping the exit lanes for SmarTrip payment).

2.2.2.2.3 Park and Ride

In general, park and ride facility operators feel they will need to conform to a regional electronic payment system that primarily addresses the requirements of transit and toll roads. As discussed below, however, certain supplementary card uses could help address park and ride requirements.

Dulles Toll Road park and ride facilities are located with the focus on capturing incoming DC traffic by offering ridesharing opportunities, and parking is free. There are around 30 VDOT-operated lots that are dedicated to park-and-ride use, with about 15,000 spaces. Including non-VDOT lots, there are about 110 facilities. A few in Loudoun County involve curbside on-street parking.

There are also several facilities where a non-VDOT lot is shared with another purpose (such as at shopping malls). VDOT generally leases the use of an agreed number of spaces and there has been contention with the facility owner in some cases about how many spaces are actually being used by park and ride drivers. The portion of the parking area designated for VDOT use could conceivably be cordoned off and the card used for free access to these spaces. Although this would not monitor the use of spaces outside the area, information that the area is frequently full would provide an indication that VDOT patrons may be using additional parking.

WMATA, MARC and VRE also operate park and ride lots. MARC and VRE are for the most part free, to help build ridership. There are 30 WMATA stations with parking (63 cashier-attended booths, each of which accept cash, SmarTrip and flash passes). About 20%

to 25% of the transactions are now from SmarTrip cards (out of a total of about 32,000 parking transactions per day).

The current SmarTrip implementation for parking always deducts whatever is the standard one-day fee for each facility, but there are opportunities to incorporate more innovative features (such as trip discounts contingent on actual use of WMATA transit or time-based charges). Also, there are some stations where an adjacent attraction, such as a cinema complex, might be willing to pay WMATA to allow their patrons to use the lot during the WMATA evening off-peak when the lots are less used by commuters.

2.2.2.3 SmartAccess Project Team

A diverse group of agencies worked together in fall 1999 to respond to the FTA "smart card operational test" solicitation. The group is composed of agencies currently involved in electronic payments (WMATA, VDOT Smart Tag, VDRPT, M-Tag, and the DC parking TransPass program) and private sector companies linked to these efforts, including the airports and Amtrak.

The intent of the proposal is to establish a common transportation payments account and migrate where feasible to a single payment instrument. The main challenge to the concept is that existing payment systems do not currently use interoperable technology. This limits the ability for the customer to carry a single fare media that can be used with all three services.

The Phase I SmartAccess approach is to retain independent fare payment media, with customers making prepayments to a regional transportation payments account that is in turn used to prepay the accounts of the individual payment systems. In Phase I, SmartAccess accounts will be limited to customers who are able to authorize auto-replenishment of the SmartAccess account from a credit card (by a pre-selected amount whenever a minimum balance is reached).

For the stored value accounts of the individual systems, the new SmartAccess account provides a new and convenient mechanism for customers to reload their accounts. Whenever an automatic prepayment of the SmartAccess account takes place, a pre-selected portion can be used to transfer an automatic prepayment for each designated individual system account. In addition, each individual system account can be set up so that whenever its balance drops below a set minimum, the SmartAccess account will be used to transfer a preset amount automatically.

Such use of the SmartAccess account would be analogous to using a customer credit or debit card to autoload the individual system account. The difference is that the transaction can be completed offline with less risk, since SmartAccess accounts are maintained to a minimum balance and since the account status is confirmed to the individual systems on a daily basis.

The SmartAccess method of automatic revaluing from a pre-arranged credit card is adopted directly from techniques common with toll collection and transit electronic payment systems. The techniques for transfers of funds and financial data would make use of established financial system infrastructure (the Automated Clearinghouse system used for the transfer of payments and deposits between financial institutions). The enhancement for the customer is to consolidate the various automatic revaluing arrangements through the single SmartAccess account mechanism.

In Phase II of the program it is suggested that the systems might migrate to a customer's single payment instrument. This would provide additional customer convenience – in addition to having a single account for automatic prepayments, the number of individual payment instruments needed would also be reduced. There are technical and business issues, relating to the different proprietary technologies involved in the three systems. These issues would need to be resolved to allow the integration of technology into the Smart Tag and TransPass systems that would allow agencies to use smart cards that are accepted by regional transit agencies.

Regardless of the outcome of the FTA operational test solicitation, the proposal development process involved many of the most crucial stakeholders for development of a regional multimodal electronic payments system. The institutional alliances and momentum that were established through this effort serve as a valuable framework for future efforts.

In February 2000, SmartAccess was one of the projects endorsed by the MWCOG Transportation Planning Board (TPB), for access to $3.9 million federal ITS funding that has been earmarked for the region.

As the SmartAccess program evolves, the details and the relationship with other electronic payment systems in the region could change. As part of the suggested ten-year vision developed for this study and detailed in section 4, we will discuss how the SmartAccess concept could play an important role in the evolution of an integrated multimodal transportation payment system for the region.

2.2.2.4 Paratransit

Paratransit refers to several different types of transit that complement conventional fixed route service. Most typical is service mandated under the Americans with Disabilities Act (ADA) for those unable to access conventional transit services due to disabilities. These are typically shared ride vans operated by an agency (not necessarily the transit agency, in many cases a social services agency) or some combination of vans and taxis that provide service under contract. In many cases the funding agency contracts with a brokerage that in turn subcontracts with numerous independent service providers. These services are more expensive to operate than conventional transit and fares charged to patrons are usually only a portion of the overall payment the service provider receives.

The ADA paratransit service offered by WMATA is known as MetroAccess, and WMATA has developed a brokerage contract for this service. Several jurisdictions have additional paratransit services that supplement MetroAccess. For example, Arlington Transit operates STAR and social services agencies in Fairfax County operate the FASTRAN service.

The smart card is seen as being very helpful for ADA use. For example, persons with cognitive limitations cannot always handle exact change requirements. A contactless card need not be removed from the purse or wallet, which can be easier for some persons with disabilities. Also, the fact that a person is receiving a discounted price is made less visible to other passengers. Transaction records on the date/time when a particular passenger's card was used would provide useful data for validating contracted trips completed, late complaints, no-show claims, etc. This could provide a systematic and cost-effective approach to quality assurance in the use of contracted services.

Submitting data to certify a completed trip, providers could receive the entire payment from the funding agency without handling any cash or paper scrip from the patron for their portion of the payment. Another benefit of a prepaid card for paratransit operations is that the card issuer would guarantee reimbursement for service providers. When these providers accept credit cards there is not usually any online authorization until the transaction is processed in the office, and this leads to some risk.

Administrative procedures to check the validity of customers for subsidized services and to bill the subsidizing agencies are often cumbersome for both service providers and subsidizing agencies alike. Smart card based transactions for subsidy trips should improve the ability for paratransit providers to offer more cost-effective service.

2.2.2.5 Taxi and Airport Ground Transportation

Taxi service refers to general "for-hire" operations throughout the region. Airport ground transportation encompasses a wider range of services, including both taxis and shared ride vans (such as Supershuttle), although "courtesy vans" have been excluded. The operational difference is that a general taxi fleet needs to be dispatched to pickup locations, although with some airport shared ride services there is also a dispatch component associated with the return leg from the city to the airport. However, the business relationships between vehicle owners and drivers are quite similar in the different types of ground transportation services.

Two common models for the business relationship between drivers and companies are:

- In some jurisdictions, for example with Arlington taxis, the company typically owns the vehicles. The driver leases the vehicle for a set amount, pays all costs associated with operating the vehicle and keeps all fares. In other locales, drivers may lease vehicles by the shift, which keeps each vehicle in more or less continuous use and results in drivers being assigned a variety of vehicles.

  In addition to owning the vehicles, the companies provide as part of the lease rate a dispatch service (and associated equipment like GPS receivers, radio transceivers and mobile data terminals) and sometimes a service for processing credit card receipts. If the driver has a regular vehicle, he would sometimes be expected to make the investment in equipment to make credit card acceptance easier, such as magnetic stripe terminals and connections with the meter. Some credit card equipment/meters are being integrated with mobile data terminal/radio equipment to enable on-line credit card authorization.

- In other jurisdictions, for example with Alexandria taxis, drivers typically own their own vehicles. Again, the drivers pay all operating costs and keep all fares, but they only need to pay the company for the dispatch and payment processing related services.

In either business model, drivers have an inherent bias towards cash fares, since these might not be entirely reported for tax purposes. This opportunity does not exist where there is a record of the transaction such as for credit card receipts (or with smart card payments). In the interviews, it was suggested that the potential increase in driver safety from carrying less cash during the shift is not as big an influence on drivers as many would think.

Offline credit card transactions lead to extra effort for the driver (and for weekly lease or driver-owned vehicles also require additional visits to the company dispatch center), to tally the slips and submit them to the company for reimbursement. Even for online

authorizations, the driver needs to visit the office to get reimbursed. In practice, these reimbursements often occur as an offset to the periodic driver payments to the company.

Transactions data collected in a smart card reader would likely be handled in an analogous manner, with the data either transferred periodically directly to the company from the terminal or transferred more frequently by wireless transmission over the radio. Drivers rarely deal directly with a credit card transaction acquirer (as an alternative to working through the company) since this would usually increase their transaction fees. There is the potential for smart card transactions to be submitted directly over a phone line to the clearinghouse from the driver's home, rather than through the company, if this did not penalize the driver's transaction fees. This would save the driver time if he did not need to visit the taxi company office to receive the corresponding reimbursement (for example, if the funds were deposited to his bank).

Another potential benefit with smart card payments would be for senior's discounts. These are currently administered in many areas using coupons provided to seniors, so that they can have a set number of discounted trips each month. These are another cumbersome item for the drivers and companies to administer, similar to credit card slips (but worth less so there is less to gain from the trouble of handling them). This capability could be emulated in a smart card, so that cards for seniors would automatically enable the allowed number of reduced fares each month (driver reimbursement would be for the full fare).

Drivers, companies and brokerages operate on limited profit margins and smart card equipment is unlikely to be implemented in these vehicles unless terminal costs are reasonable. In additional to reasonable equipment costs, it also seems likely that smart card acceptance will not be high until there is consumer demand for this payment option. For example, credit card acceptance is only beginning to become more common. It will also be important for the size of smart card terminals to be reasonable (the expectation of the drivers seems to be for something similar in size to a credit card terminal).

2.2.3 Southern I-95 Corridor

The I-95 Corridor generally refers to the densely populated and highly traveled area running up the eastern seaboard from Virginia to Maine along I-95. For this study, the southern portion of this corridor is of primary interest.

2.2.3.1 Amtrak

Union Station is the major hub for Amtrak's regional service as well as providing access to regional transit services. As Amtrak introduces Acela Express high-speed rail service throughout the corridor, the use of Amtrak for inter-city commuting may increase.

Amtrak's new revenue collection system involves the on-board inspection of bar-code tickets purchased in advance for designated seats. The new system will equip inspectors with hand-held terminals (scheduled for all services nationwide by late 2000). The primary intent of using the hand-held terminal is to gather information about which seats remain unoccupied due to "no-shows" and transmit this information to wayside systems that link with the Arrow reservation system. Additionally the system will provide detailed passenger manifests that can be uploaded to a central computer system. As part of this communications and payment system upgrade, Amtrak is considering introducing a smart

card as a method to purchase items in the Café Car and develop as well a loyalty program for its frequent travelers.

2.2.3.2 Other Regions

2.2.3.2.1 "Greater" Washington Region

This includes portions of West Virginia, Richmond (and intervening counties south of Prince William County) and the Baltimore region (including the surrounding counties of northeastern Maryland). West Virginia and the Richmond region are not involved in any notable initiatives for transportation payments, with the exception of the Smart Tag toll collection facilities in Richmond. In the Baltimore region, Maryland MTA operates (in addition to the intercity services such as MARC and commuter buses) the subway, light rail and bus systems. There are also several electronic toll collection systems operating in the Baltimore area, collectively referred to as the M-Tag system.

Maryland MTA is participating in the current WMATA farebox procurement (discussed previously). For the Baltimore region, city buses are expected to procure new fareboxes. Also, the city subway system is expected to replace their current fare collection equipment at faregate arrays, with a farebox in the booth coupled to readers at individual faregates. Baltimore fareboxes would support magnetic stripe card processing and there is the additional option for smart card processing equipment. Some Maryland MTA commuter bus routes may also implement stand-alone smart card readers. Magnetic cards used in Baltimore will not need to be compatible with the magnetic stripe tickets used in the DC region. Smart card readers would allow SmarTrip stored value to be accepted for fare payment and allow the transaction data to be submitted to the SmarTrip system for reimbursement.

2.2.3.2.2 Philadelphia/Wilmington

The primary regional bus and rail transit operator (SEPTA) is currently investigating significant revenue systems enhancements, aimed at streamlining fare options and operations. There is currently a diverse and complex array of fare options and fare media, so there are likely to be both changes in fare policy and an effort to develop a common fare media (which could be either magstripe or smart card based).

Discussions are underway with other regional transportation agencies about participating in supporting a common card for regional transportation payments, including the commuter rail operation to NJ suburbs (PATCO), the Philadelphia Parking Authority. Delaware First State Transit and the Delaware River Port Authority toll bridges.

The Pennsylvania Turnpike is currently implementing an E-ZPass system. Since its current operations have all customers stopping at tollbooths, there have been discussions that the current operations could directly benefit from accepting a regional transportation payments card.

2.2.3.2.3 New Jersey/New York City

The NYC Transit MetroCard fare collection system uses a stored value magnetic stripe ticket that can be used with all subway stations and buses. The system rollout was completed in 1997 and the system is becoming increasingly popular as an alternative to cash (current market penetration is roughly 80%-85%). MetroCard has been used to enable several fare

policy innovations (free transfers between bus and subway, a 10% bonus on revalues of at least $15 and unlimited ride passes).

MetroCards are distributed and revalued through automated vending machines available at subway stations. The number of subway MetroCard revaluing machines is currently being increased, in an effort to be completed in the first quarter of 2001. A factor that has limited MetroCard market penetration is that many bus users are not subway users and don't find it convenient to visit a subway station. NYCT is investigating options for "out-of-system" distribution, including dispensing MetroCards through bank ATMs and merchants.

New York City MTA is expanding the role of MetroCard for fare coordination with other transit services, including NYC MTA commuter services and private bus operators (that are affiliated with and subsidized by the NYC MTA). There is increasing interest in fare coordination with transit agencies outside NYC MTA, such as PANYNJ and NJT.

PATH is in the process of replacing their existing magnetic stripe fare collection system with more modern and supportable equipment, using a combination of magnetic stripe and smart card fare media. A recent study initiated by the PANYNJ (similar in scope to this study and also completed by the Volpe Center/Multisystems team) examines issues related to developing a NYC region multiple operator transit fare system.

NJT operates an extensive network of rail and bus operations throughout the state. Bus fares use the onboard collection of cash or tickets purchased in advance, together with automated vending machines. Rail fares combine onboard fare collection with the onboard inspection of tickets purchased in advance. Significant revitalization of the overall fare policies and fare collection methods is being considered as part of a current statewide bus farebox upgrade project, to streamline fare options and operations.

There are three different groups of E-ZPass toll agencies in the region:

- **NYC MTA Bridges and Tunnels (MTA B&T):** There are nine crossings operated in the New York City region between points in New York State. NYC MTA has a joint E-ZPass Customer Service Center (CSC) with the New York State Thruway Authority and the New York State Bridge Authority.
- **PANYNJ:** Operates six bi-state E-ZPass crossings in the New York City region. They plan to eventually participate in a joint CSC with the New Jersey Consortium toll agencies, but are participating in the New York CSC in the interim.
- **New Jersey Consortium:** The New Jersey Turnpike Authority, New Jersey Highway Authority and South Jersey Transportation Authority have formed this alliance for their current E-ZPass implementation effort. Delaware toll agencies also participate in this consortium.

2.2.3.2.4 E-ZPass

The PANYNJ, NYC MTA Bridges and Tunnels, the New York State Thruway Authority, the New Jersey Turnpike Authority, the New Jersey Highway Authority, the South Jersey Transportation Authority and the Pennsylvania Turnpike Commission joined together to form the E-ZPass Inter Agency Group (IAG). Since that time, the IAG has grown and now also includes the Delaware River Port Authority, the Maryland Transportation Authority, the Delaware Department of Transportation, the New York State Bridge Authority, the

Massachusetts Turnpike Authority and the West Virginia Parkways Authority. This makes a total of 13 agencies in 7 contiguous states.

The purpose of the IAG is to form the institutional framework for the evolution and growth of regional revenue collection interoperability between independent toll collection agencies. The initial steps were taken in the late 1980's, when the initial E-ZPass collective vision (of "one transponder, one account") was developed. Since all the available transponder technologies were proprietary, the agencies collectively selected a common technology (from Mark IV) for the individual agency procurements.

Each E-ZPass system uses a Customer Service Center that is independently procured and operated by one or more agencies. CSCs establish prepaid accounts and issue vehicle transponders, which automate the process of identifying the applicable prepaid account at the point of toll collection and of checking that there is a suitable balance. A transponder issued by any E-ZPass agency can be used to pay the toll at any E-ZPass agency. These systems also involve complementary technology for operations management, communicating information to drivers and recording license plate numbers of toll evasions:

- There are currently four established CSCs in the E-ZPass system: (1) for NY agencies; (2) for the NJ and Delaware agencies; (3) for the DRPA bridge crossings between NJ and Pennsylvania; and (4) for the West Virginia Turnpike.
- The earliest agencies to deploy E-ZPass systems were NYSTA, NYC MTA B&T, NYSBA and PANYNJ. The four NY agencies use a common CSC operated by Lockheed Martin.
- The NJ and Delaware agencies have formed a consortium for their E-ZPass deployment, although deployment is still in process on the NJ Turnpike. These agencies use a common Customer Service Center (CSC) operated under contract by Chase Manhattan Bank.
- The Massachusetts Turnpike operates the FastLane system, which although it is operational is still in the process of being integrated as an E-ZPass CSC.
- The M-Tag toll facilities in the Baltimore region have been in operation for several years and have a CSC operated by Lockheed Martin, and these are in the process of being converted to E-ZPass facilities.
- The Pennsylvania Turnpike currently indicate that the initial stage of their E-ZPass implementation, involving some lanes for passenger vehicle use at interchanges between Harrisburg and Philadelphia, is scheduled for fall 2000 completion.
- The Maine Turnpike is reported to be considering converting the existing transponders based system to Mark IV equipment so that they can join the E-ZPass system, with a decision anticipated in fall 2000. New Hampshire recently initiated an effort to join E-ZPass.
- Virginia Smart Tag facilities use compatible Mark IV transponder technology but so far VDOT has elected not to join the IAG and E-ZPass. One reason may be that their facilities are primarily used for local commuting and do not run along the I-95 corridor.

Current data suggests there is only limited use of Smart Tag facilities by transponder owners from the various E-ZPass facilities.

There has been interest at the E-ZPass agencies in developing a mechanism to marry the Mark IV transponder with a regional transportation smart card. Mark IV has developed a transponder into which a contact or dual interface smart card could be inserted. This would mean that smart card transactions could be completed through the transponder in the manner E-ZPass payments are made today: This was announced as a joint product, called "Smart Fusion", with Touch Technology International in May 2000.

2.2.3.3 Beyond Transportation

2.2.3.3.1 Federal Government Employees

As discussed earlier in this report, the General Services Administration (GSA) selected five different consortia of vendors in May 2000 for participation in future smart card system deployments by various agencies of the federal government. The consortia will make a wide range of technology and services available for these systems, although the decisions about when to deploy and about which technologies to use will lie with the individual agencies. Some federal agencies may incorporate contactless interface and multiple application operating system capabilities to support transit fare payment using their cards.

The Department of Defense is expected to deploy first (expected to begin in 2002), providing cards to about 4 million employees and contractors nationwide (many Department of Defense cards will be issued to DC area residents). These cards are expected to primarily use a contact interface and to focus on access to secured server software. Many DOD cards may carry additional applications for access to medical and dental records, inventory control for weapons and other equipment, and tracking of soldier and sailor training. Some may also carry private sector programs like credit and debit services, electronic purses and loyalty schemes.

2.2.3.3.2 Financial Institutions

Financial institutions have made several attempts in recent years to introduce smart cards to their customers. These efforts include the trial introduction by banks of stored value open purse systems in Atlanta during the 1996 Olympic Games as well as subsequently in a small area of Manhattan. Financial institution smart card based open stored value purse systems will be discussed in greater detail at a later section of this report.

The general conclusion of the banking industry about open purse systems appears to have been that without relatively ubiquitous acceptance of the purse by merchants in a region, customer interest was limited. However, without customer demand, there was merchant resistance to installing the new equipment required to accept smart cards. This "chicken and egg" situation led to an overall retreat from smart card deployment towards the end of the 1990's. There was a good deal of discussion about how deploying a stored value purse for use with a mass market application such as transit could establish the "critical mass" of customers needed to create serious merchant acceptance interest. This interest helped spur the development of dual interface smart card technology.

Financial institution interest in stored value open purses remains. Also, the emergence of multiple application operating systems technology (such as MULTOS, Java Card and

Microsoft Windows for Smart Cards) has supported a renewed emphasis on supporting a range of card applications. Cards with conventional proprietary operating systems can support more than one card application. The distinguishing features of these new "open" operating systems are that:

- The card issuer can add or remove applications from the card after issuance without involving the systems integrator.
- The software for new applications is written in a common programming language (especially true for Java Card and Windows for Smart Cards), and this opens up the range of commercial sources for these new applications.

This will help address one of the "business case" concerns of financial institutions, that the revenues from open stored value purses might not be adequate to generate a suitable return on their investment in smart card systems deployment. These complementary financial smart card applications include:

- Transferring credit and debit card data from magnetic stripe to the chip. Not only is this intended to increase the security of this data, but also the card acceptance infrastructure is expected to begin to selectively authorize transactions online. For at least some regions of the world, it is understood that major credit card associations (such as Mastercard and Visa) may stop compensating financial institutions for magnetic stripe card fraud as early as 2005. Banks in the UK and Japan have already announced transition programs.
- Loyalty programs have emerged as a powerful marketing tool, and smart card based loyalty offers the potential to increase security, reduce administrative costs and allow more responsive marketing of rewards to customers.
- The emergence of Internet-based commerce, and the expected increase in the packaging of smart card readers with PCs based on the smart card support features in Microsoft Windows 2000, has fueled interest in the home use of smart cards by consumers while shopping online. This involves both the credit/debit and loyalty program uses discussed previously. It has also created a new application category, the on-line digital certificate, which unlocks access to an online repository of credit/debit and loyalty program information.
- The American Express Blue Card has been the early market entry for the concept a smart credit card. Launched late in 1999, the Blue Card has generated considerable consumer demand. The initial version only provides the digital certificate on the chip, with credit card data remaining on the magnetic stripe. There is no open system stored value purse. Early in 2000, the complementary BlueLoot online purchases loyalty program was announced. By mid-2000, American Express had announced plans for a European version of the card as well as for the introduction of multiple application cards using the Java Card operating system (customers may eventually be able to choose which card applications to download onto or remove from their cards). A competition for Java application software developers to create innovative smart card based applications for a cash prize, referred to as Code Blue, was then launched.
- In September 2000, three major United States Visa card issuers (First USA, FleetBoston and Providian) announced plans to launch smart credit cards conceptually similar to the

American Express Blue Card later during fall 2000. Although the primary initial chip application is expected to be a digital certificate for internet commerce, the cards are expected to be later enabled to support a bundle of card applications for which Visa will be providing support to its member banks. These applications are currently being promoted as Visa Payment, Visa Access and Visa Loyalty.

As part of this broader application environment, financial institution cards may emerge which support a stored value open purse. Some of these issuers may choose to use a dual interface for some or all of their cards to support carrying a transit payment application on their cards (whether or not the transit fare payment would be from the open system purse or from a closed system purse). It is also conceivable that financial institutions would consider placing some or all of their financial smart card applications on a card issued by transit agencies. However, the financial institutions have placed great value on the customer relationship and branding opportunities that have been associated with issuing their own cards in the past and generally perceive as a threat other organizations being interposed between them and their customers (which they refer to as "disintermediation").

The United States Department of Justice launched an anti-trust action against Visa and Mastercard in June 2000. This action asserts that these associations, since some major banks have ownership in both, have limited the degree to which they differentiate their credit card products through the use of advanced technologies such as smart cards. It also asserts that the associations have prevented other credit card companies, such as American Express, from being distributed through banks. This will not be resolved quickly, but could eventually have a substantially impact on the credit card industry and the role for smart cards.

3 Market Segments

3.1 Importance

There are several reasons why it is important, in designing the vision for a regional electronic payments management system, to start with examining the customer market segments:

- System functional requirements should be based on the needs of target market segments.
- Target market segments can help determine the implementation strategy of the overall program, including the initial pilot deployment– functionally, geographically and in terms of participating agencies.
- Understanding non-transportation applications used by target market segments can assist in identifying partners for system participation.

This section examines two different ways of segmenting the regional travel market, in each case considering which segments would appear to most directly affect the requirements for a transportation payments system oriented towards multimodal travel:

- A largely intuitive segmentation based on trip purpose and the associated frequency of travel
- The market segmentation developed through WMATA market research, based on characteristics (such as income, home/work locations and attitudes towards transit use) determined from surveys sampling riders and non-riders throughout the WMATA service area

This section is primarily aimed at identifying market segments that an electronic payment system could try to target. These target market segments are discussed at the end of this section. In section 4.2, some specific opportunities are identified for the longer-term vision that is developed for the system to leverage these target markets.

3.2 Market Segments Based on Trip Purpose

3.2.1 Frequent

3.2.1.1 Commuters

Commuters travel to and from their place of work. These trips usually connect areas of employment with residential areas. One of the characteristics of commuting travel is its regularity in terms of origin/destination, time of day, etc. However, several trends are making commuting less predictable, including telecommuting, business travel, flexible work schedules, etc.

3.2.1.1.1 "Choice" Transit Commuters

This refers to commuters who are using transit even though they have alternative means of transportation, particularly access to a vehicle. There are a variety of reasons why these commuters use transit, including reduced vehicle mileage, avoiding the need for a second (or

any) vehicle, avoiding tolls/parking fees, reduced automobile emissions, more direct access to their workplace, etc. For various reasons, choice use of transit is fairly high for the District and other highly urbanized parts of the Washington region.

A feature of commuting travel for choice transit users is that many will also use their car for a portion of their trip (for example, a drive/park/transit trip chain for the inbound trip). Some may even vary the extent to which they use transit depending on driving conditions (for example, only using transit when weather conditions are poor or there is severe traffic congestion). Others may vary the level of transit use based on the day's activities (such as driving all the way to work on days when they have some additional personal or business trips to make during the day).

Also important to consider is the potential for ridership and revenue increases if transit can improve how it addresses the needs of commuters whose choice is to avoid transit or use it infrequently.

3.2.1.1.2 "Captive" Commuters

This term refers to those who do not have any choice in how they commute:

- Usually refers to those who do not have access to a vehicle and need to use transit. In some cases, these people might be quite content with their transit commute. In some other cases they might have concerns related to transit fares, schedules, security etc., but simply have no alternative.
- A less commonly considered meaning for this term are those who are captive because they have no choice but to drive, if transit does not serve their origin or destination.

3.2.1.2 Non-Commuters

Those who are not working or are seeking employment can be distinguished from commuters by the considerably less predictable nature of their travel. They can make frequent trips, especially if they have access to a car or are able to acquire a period pass for transit. Reasons for frequent travel can include wide-ranging shopping travel for bargains, volunteer work, employment searches, etc.

3.2.1.3 Students

Students, for the most part in secondary or post-secondary education, have travel patterns in many respects similar to commuters. The most important differences are the somewhat less regular travel patterns and the time periods during school breaks when their travel demand falls off.

3.2.2 Occasional

3.2.2.1 Shopping/Entertainment

This category covers much of the less frequent personal travel. The choice between transit and driving (or a combination of the two) is subject to the same considerations as for commuting. One difference is that many choice transit commuters with access to a vehicle will tend to use the vehicle more for these non-work trips. Much of the transit use in this

segment is restricted to (1) those who do not have access to a vehicle; (2) those who for philosophical reasons prefer to use their vehicles less; (3) those who are visiting shopping/entertainment facilities that are more directly or cost-effectively served by transit. Such travel is primarily on evenings and weekends, with specific commuting patterns largely determined by the destinations (such as entertainment districts, jurisdictions with lower sales tax, etc.)

3.2.2.2 Tourist

A tourist is usually only in the area infrequently. This can involve frequent travel during a brief period. Many tourists do not have access to a vehicle during their visit (or choose not to use their vehicle much because they are unfamiliar with driving in the region). Transit use is quite prevalent for tourists in the Washington region. Many of the attractions are well served by transit and Metrorail itself is to some degree considered an attraction. A challenge with promoting tourist transit use is the unfamiliarity with services, fare structures and fare payment methods.

3.2.2.3 Business Travelers

As the seat of national government, a center for international affairs and a major center for business, the Washington region hosts many business travelers (including governmental business). These travel patterns lie somewhere between those of the tourist and those of the commuter. The business day travel pattern is often much like commuting, with the origin being an airport or hotel and the "choice" being between transit and a taxi or rental car. As with tourists, business travelers need help with understanding the transit services available and how the fare system works. This is especially true for the Washington region where so many travelers are from outside the country. Business travelers are often pressed for time and need to make travel decisions quickly.

3.2.3 Target Market Segments for Participation in Regional Programs

Certain factors determine which segments can be best served by a smart card based fare collection system, and the order in which segments should be addressed as the system is built up incrementally over time:

- Smart cards cost more individually than magnetic stripe tickets, but can be used for a period of years rather than weeks. Smart cards are best suited for frequent and long-term use, where many magnetic stripe tickets that would be needed over the same period of time. This suggests regular users, such as commuters, as a target market segment for early deployment.
- Students could be another target segment. Student transit use is often captive and many of these students might not become choice transit commuters. With transit made more appealing and convenient during their student days, more could be retained later. Students have also been receptive as early adopters of "high-tech" equipment. One way to target students would be to pair the transit application on their cards with campus applications they use everyday.

- The entertainment/shopping segment could be targeted, since many may not use transit for daily commuting. Smart cards, perhaps through a joint loyalty/incentives program with popular retailers and attractions, could get some to give transit a try. By making transit convenient and appealing, some might be converted to more regular transit use for commuting.

3.3 Market Segmentation Based on WMATA Market Research

WMATA has commissioned extensive market research. The following discussion highlights some important findings from the report documenting the "1999 WMATA Service Area Usage and Attitude Assessment Research", released by QS&A Research and Strategy in July 1999. Unfortunately, this market research did not directly address how the fare structure and payment methods (and fare system differences between agencies and modes) affect attitudes. Much of the Metrobus service area corresponds with the service areas of the local bus agencies, so many of the customers surveyed also use (or could use) these other transit services.

3.3.1 Service Area and Travel Profile

- **Demographics and Commute Patterns:** Newer residents most likely live in Fairfax, Arlington, Alexandria and the District. Fairfax has the most high-income persons, while the District and Prince George's have the lowest. The District is the main destination for commuters, followed by Montgomery and Fairfax.
- **Trip Purpose:** The average of 13.5 total trips per week is about evenly split between commute and personal trips.
- **Mode Share:** Rail is used more for business than personal use, while buses are used more evenly between these purposes. Metrorail commuting use is greatest for District and Arlington residents, and least for Montgomery.
- **Travel to Metrorail Stations:** About a quarter of Metrorail riders use Metrobus to get to the station, plus about 5% more use another bus agency.

3.3.2 Transit Rider Characteristics

- **Past Week Riders:** About 17% of service area adults had used Metrorail in the past week (9% for Metrobus), although most riders have unlimited access to a car. Frequent Metrorail riders mostly feel they have convenient bus service to the station. While Metrobus riders tend to be less affluent than the general population, this is not the case for Metrorail riders.
- **Attitudes:** Features reported to support increased Metrorail use include: (1) a guaranteed ride home; (2) improvements to bus connections at stations; (3) employer subsidies; and (4) more shops and services near stations.

3.3.3 Market Segmentation

Cluster analysis with rider and non-rider characteristics suggested the following market segments.

3.3.3.1 Core Urban Transit Market (23%)

- The least affluent, and use both Metrorail and Metrobus frequently
- Have transit-friendly attitudes and express interest in using transit more frequently in response to potential improvements
- Although most have access to a car, choose transit because they have less access to free or subsidized parking at work and more access to Metrochek.

3.3.3.2 Eroding Urban Metrorail Market (7%)

- With average incomes, many live in the District or surrounding highly urban area and are influenced to use transit frequently if it is convenient and they have access to Metrochek
- Even though transit is well suited to the travel patterns of this segment, the income range makes owning a car possible as well. This leads some in this segment to decrease their use of transit.

3.3.3.3 Affluent Suburban Metrorail Market (18%)

- The most affluent, most live in Fairfax or Montgomery (and often work in the District) Some use transit for commuting but mainly limit themselves to Metrorail
- If transit fits their work schedule and travel patterns, the absence of free or subsidized parking at work and access to Metrochek will promote transit use

3.3.3.4 Suburban Auto-Attached (28%)

- Also affluent and tending to live in Fairfax or Montgomery, use transit little and have attitudes not receptive towards transit
- Live where less well served by transit and feel they need the car during the workday

3.3.3.5 Receptive Suburban Non-Users (10%)

- Although less affluent, similar to the suburban auto-attached in how little they use transit and why
- Open to using transit if more accessible; want to avoid the stresses of commuter driving and would like to save money

3.3.3.6 Latent Market for Enhanced Bus Service (14%)

- Less affluent and with more transit friendly work schedules; receptive to using transit but it is not accessible to the suburban locations where they live and work.

3.3.4 Strategies for Encouraging Transit Use

Overall, the WMATA market research concluded the travel environment is increasingly transit-friendly and several strategies were suggested to try to translate this into ridership improvements:

- Continue to market the MWCOG Guaranteed Ride Home program and Metrochek
- More shopping and services near stations; portray the different transit agencies and modes as a single system
- Experiment with non-traditional bus service, and publicize successful experiments
- Public outreach and education, including targeting newcomers

3.3.5 Target Market Segments

The following table highlights dimensions of the WMATA market segments that roughly correspond with multimodal travel importance:

- With negative attitudes to transit, are less likely to include it in their trips
- With lower incomes, may include transit in their trips to avoid parking costs and take advantage of Metrochek
- With work or home not near transit, will not likely have a transit-only trip.

	Attitude to Transit	Income Level	Proximity to Transit	Main Potential Home to Work Trip
Core Urban	Helps them avoid need for a car	Lowest	Good	Transit only
Eroding Urban	Want to switch to car	Average	Good	Transit only or car only
Affluent Suburban	Will use if convenient and economical	Highest	Moderate	Car only or car / transit
Suburban Auto-Attached	Resistant to transit	High	Poor	Car only
Receptive Suburban	Open to transit, but not familiar and don't see it as practical	Moderate	Poor	Car only or car / transit
Latent Suburban	Have considered using transit more, but logistics interfere	Low	Poor	Car only or car / transit

The main opportunities for ridership were linked with the "core urban", "latent suburban" and "receptive suburban" segments, together nearly half the service area adults surveyed. They all have receptive attitudes towards using transit more often if the accessibility, service and convenience were improved.

Increased transit use by the "core urban" segment will not likely increase multimodal trips, since in many cases they do not own a car.

The other two are suburban markets and not strong transit users. Rail extensions or bus routes may not be coming soon to where they live and work. Streamlining the payment processes for tolls, parking and transit can promote combined drive/park/transit commuting.

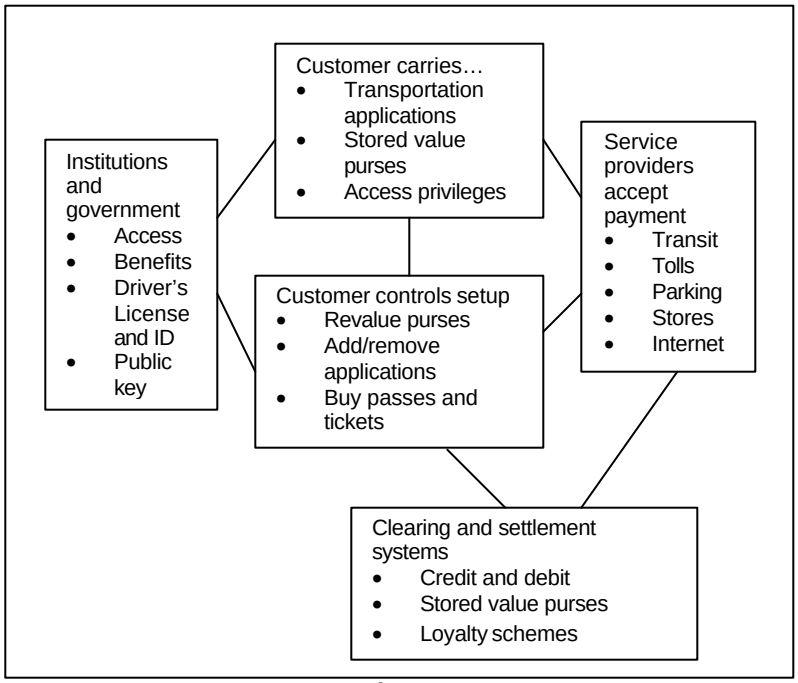
The "affluent suburban" market segment also seems important for multimodal travel. It was not highlighted in the WMATA research because the level of transit use was considered stable and not likely to grow much further.

4 Suggested Ten Year Vision

4.1 Overview

It will be important for the agencies to continue to work together, to put in place a guiding vision for a smart card based regional transportation payments system. With this initial vision established, decisions about the long-term implementation strategy and early implementation efforts can be made more effectively.

Figure 4: Customer Centered Vision



By 2011, the enhanced regional payments infrastructure may look something like this:

- **Flexible Multiple Application Cards:** Most people in the Washington, DC region (and other regions as well) will have a smart card. It will be used for a variety of payments that are not well-suited to the use of credit or debit cards, because of their low value or because on-line authorization is not a desirable approach (both transportation and non-transportation payments). It will also be used for many other purposes, such as access to

facilities, services and networks or the secure storage of personal data (medical records, driver's license, public key certificate, etc.). Each person's card will carry applications that support the mix of uses they have selected. The card will be used with many different transportation service providers, including most regional transit agencies, toll authorities and parking facilities, as well as other transportation uses such as taxis and airport ground transportation.

- **Role of the Transit Card Application:** Cards will be available through many sources, and have a multiple application operating system that allows customers to add or remove any of the various card applications that are available (to allow the card to be used for different purposes). For example, with transit fare payment, the focus will have shifted from issuing specialized cards to issuing a specialized card application that allows its fare collection equipment to determine what fare is required (in accordance with its fare policy). This specialized card application could carry a stored value purse of its own or simply determine the fare required for payment from another stored value purse application on the card. One role of the transit application will be to support a flexible array of data that create opportunities for fare policy innovations by individual agencies (discounts based on frequency of usage, linked trip discounts, etc.).
- **Payment Transactions:** The way the card communicates with terminals will likely have evolved from the current techniques. The contactless interface may have superceded the older contact interface. Newer interfaces that are currently emerging (or are yet to emerge) may have an important role. One currently emerging possibility is the "Bluetooth" short-range wireless interface. The chip may not even appear in the form of a card, but rather be housed in other common personal effects such as a mobile phone, pager, watch, ring or wallet. When the card is used with a roadside terminal at a toll plaza, parking lot or fast food outlet, vehicles will have a facility to let the payment transaction be completed conveniently (generally while the vehicle is moving). Current devices such as transponders will have begun to be superceded by equipment purchased with the car.
- **Revaluing Transactions:** Devices that allow people to increase stored value or otherwise adjust the card configuration will take a variety of forms, such as kiosks, phones, computers, interactive pagers, etc. These devices will likely connect to the payment system infrastructure through a fixed or wireless Internet connection. For revaluing, people will either use cash or a financial card directly or have automatic periodic revaluing arrangements.
- **Wide Choice in Customer Payment Options:** People will have one or more stored value purses of their choice in the card, as well as card applications providing the credit and debit card supported on magnetic stripes now. Banks will still issue the credit and debit applications, but stored value purses will be available from both banks and other providers. The card will also carry other payment-related data for various purposes, such as passes, tickets and loyalty programs. At some locations, the customer will select which payment method the terminal should use, similar to with current terminals that can accept either your credit or debit card. For transportation payments, where transaction speed is more important, part of the role of the specialized card application will be to

select which payment method to use (this would depend on some combination of customer selected preferences and agency policies).

- **Support Multiple Third Party Stored Value Purses:** Accepting smart cards for payment means that a service provider's central system will need connections with the clearing and settlement systems of any of the payment methods customers expect to be able to use. Just as most stores currently work with all major credit and debit card systems, transportation payment systems will need to be linked with these plus all major stored value purse systems.

Payment systems are a rapidly evolving area of technology, and if the recent past can serve as a guide the pace of change will accelerate. In ten years time it is difficult to project much with certainty (for example, ten years ago most people had never heard of the Internet). However, for the substantial investment a transportation agency needs to make in a new payment system, an economic life of at least ten years will likely be required. Design criteria need to focus on building in provisions to support adapting and extending the system later to keep pace with features required by customers, technology available and changes in the vendor marketplace.

Transitional steps:

- **Transit only (2003-2005):** All the major regional transit agencies and some parking facilities will accept the cards issued by agencies, using a central clearinghouse. Each agency may maintain an independent fare policy. Agencies will still accept cash, and some agencies will also use magnetic stripe cards to support occasional users. A few other systems have been set up (such as at universities) and arrangements have been made for some of these cards to support transit use.
- **Expanding system (2006-2008):** The transportation system expands to include private sector operators, more parking facilities and toll roads. Customers will see toll roads involvement as a Smart Tag enhancement, letting them use the card through the transponder. Others (government, mobile phone providers, etc.) will issue non-transportation smart cards, and these cards will often support transportation payments as well. Banks have begun to get involved, issuing their own cards and arranging for the cards of other systems to carry the bank's open purse scheme, and leveraging this base of card users to pressure retail merchants to invest in upgrading their point of sale terminals. Occasional transit users will often have a card for some other purpose that also works with transit, so agencies have begun to phase out magnetic stripe equipment once it reaches the end of its economic life.

4.2 Objectives

The longer-term vision must be consistent with the fundamental objectives the regional transportation agencies have in developing payment system enhancements.

4.2.1 Addressing Market Segments

The interpretation of the WMATA market research provided earlier in the report suggested that the most important segments for multimodal travel involved people with suburban

locations who don't have attitudes deeply resistant to transit. Three segments based on trip purpose and frequency of travel were also identified:

- Commuters
- Students
- Occasional shopping/entertainment users

The vision is oriented towards supporting a multi-purpose payment media with specific features configured to the individual need of customers. Customers can gain access to the card purposes that are most valuable to them. Transit applications can support fare policies oriented to encourage transit use:

- For commuters this could mean frequent trip discounts, free transfers and a guaranteed space at the park and ride lot.
- Students would value the ability to combine on-campus applications onto their card and have convenient a place (i.e. the Internet) which fits their lifestyle to manage their card and applications.
- Occasional shopping/entertainment users might be influenced to use transit more frequently for these trips through innovative features using incentives that leverage their trip purpose. For example, having a ticket on the card for a particular event could be used by the transit card application as a trigger to apply a discount for transit travel during the time before the event on the routes that would take them there.

4.2.2 Enhancing Current Systems

The new system concept needs to build on previous capital investments and existing partnerships. This concept can enhance existing systems that are still operating within their economic life. This vision supports this objective:

- Each agency chooses when to migrate from its current fare media and system to the new regional system.
- Agencies may integrate existing fare collection systems equipment into the new regional system using readers for the new fare media.
- Existing agency central computer systems may be integrated into the regional clearing and settlement systems.
- Customer service facilities and fare media distribution arrangements may be adapted and incorporated into the new regional systems for distributing smart cards, revaluing stored value and purchasing transit fare products.

4.2.3 Framework for Ongoing Enhancement and Expansion

This vision is consistent with developing the systems in a way that allows for expanding the scale of the system as well as for incorporating new equipment with additional capabilities or from a different vendor:

- The centralized multiple agency clearing and settlement system concept could be operated by the transit agencies or by a third party, and helps to readily integrate a new service provider.
- Smart card multiple application operating systems support the addition or deletion of new card applications without need to replace previously issued cards.
- The transit card applications can be customized after card issuance, which allows individual agencies the continuing ability to adjust their fare policies independently.
- Future potential smart card based systems, such as an open stored value purse systems operated by financial institutions, could eventually be accepted for use in transportation payments.

4.3 Funding

4.3.1 Alternatives

There are several potential funding routes to explore, and the options vary with the different elements of the overall system involved. In many cases, these options are not mutually exclusive. This means that various parts of the overall system could be funded using different mechanisms.

The underlying basis for the potential funding mechanisms identified is that funding can be by agencies and by third parties, and that where the infrastructure funded by one party provides services that benefit another there could be some type of compensation. Taken together, the mixture of funding mechanisms used must be closely interrelated with the ownership models and business structure for different parts of the overall system as well as the operating agreements for each individual participant.

- Agency smart card accepting equipment, including card readers for collection equipment and the communications infrastructure to consolidate the payment transactions and send them to the clearing and settlement system for reimbursement:
  - Each agency could fund its own equipment.
  - One agency could fund equipment for one or more other agencies on any mutually acceptable basis.
  - A group of agencies could collectively fund equipment through a cost-sharing formula.
  - A third party could be paid on an ongoing basis to install and operate equipment owned by the agency

- Clearing and settlement systems:
  - One agency could fund a central system and be reimbursed for its use by other system participants.
  - A group of agencies could collectively fund a central system though a cost and revenue sharing formula
  - A third party could install and operate a system that acts as a service bureau (meaning that the third party owns the system and might provide similar services using the same system to additional customers) paid on an ongoing basis, for supporting the transportation card applications and the agency level computer systems
- Smart cards:
  - The cost of smart cards could be fully or partially covered through fees or deposits from cardholders.
  - One agency could pay for all of the smart cards (or only for those it issues), and be reimbursed on an ongoing basis for use of the transportation card applications by other agencies or for the use of any non-transportation applications on the card it funded.
  - The agencies could collectively pay for all the smart cards, being paid on an ongoing basis for the use of any non-transportation applications on these cards and sharing costs and revenues through agreed formulas.
  - Some or all of the cards could be paid for by a third party, potentially an operator of a non-transportation card application such as a financial institution or a university, and agencies would pay on an ongoing basis as these cards are used for transportation payments.
- Card issuance and revaluing equipment:
  - Each agency could operate some of the overall card issuance and revaluing infrastructure, being paid on an ongoing basis for any issuance services for cards owned by a third party or revaluing services for third party applications.
  - The agencies could collectively own and operate infrastructure for issuing and revaluing cards, being paid on an ongoing basis for issuing any cards owned by others, or revaluing any non-transportation applications, sharing costs and revenues through agreed formulas.
  - One or more third parties could own and operate card issuing and revaluing equipment and agencies would pay on an ongoing basis as this equipment is used for issuing cards owned by an agency or to revalue the transportation card applications.

4.3.2 Cost Estimate

The following table provides a rough cost estimate of capital and annual transaction fees for the expanded regional smart card acceptance system that might develop over the 3-5 year timeframe (as elaborated on in the following sections):

Component	Cost
WMATA SmarTrip Capital Costs	$30-$35 million
Other Agencies Regional Smart Card Capital Costs	$8 million
Regional Smart Card Clearinghouse Transaction Fees (First Year)	$2-$6 million/year
Smart Cards Initial Issuance (Excludes Replacement Cards)	$3 million
SmartAccess System Capital Costs (Phase I)	$4 million

4.3.2.1 System Overview

A rough cost estimate has been prepared for the multimodal and multi-agency transportation payments system that might develop over the 3-5 year timeframe. This estimate assumes the system is built on the foundation of the current SmarTrip implementation and other established electronic payment initiatives, with the following basic elements:

- Smart Tag, the regional electronic toll collection system, which will continue to be used to support toll facilities in Virginia;
- TransPass, the smart card acceptance system for the public parking in the District of Columbia, which is will likely be implemented soon;
- Regional smart card acceptance system, that builds on the progress achieved by WMATA with its recently introduced SmarTrip system and includes the following aspects:
    - SmarTrip as currently fully deployed for Metrorail and WMATA parking
    - SmarTrip acceptance fully deployed for Metrobus, scheduled for completion by 2003 based on the current farebox procurement (which could include changes to the current SmarTrip implementation)
    - Interoperability for the SmarTrip readers to also accept smart cards issued by regional agencies other than WMATA
    - SmarTrip readers for the transit agencies in the region that link most directly with WMATA services, for VRE and MARC ticketing issuing devices and for Dulles airport parking.
    - A jointly operated regional smart card clearinghouse to support multiple agencies, to complement the current single agency system operated by WMATA. The jointly operated clearinghouse is assumed to be a privately owned clearinghouse to which the participating agencies pay transaction fees. This clearinghouse could involve either a single “centralized” system or a “decentralized” collection of systems that

have bilateral arrangements with each other (clearinghouse alternatives are discussed in further detail later in the report).

- Revaluing facilities, funded as an extension of the clearinghouse responsibilities, at Metrorail stations, commuter rail stations, bus agency fare media sales outlets, airport terminals and retail stores.
- Some other smart card systems may eventually carry the transportation payments application in conjunction with their own applications. Examples of such third party systems include the smart cards expected for Department of Defense employees and contractors as well as the American Express Blue Card. Having the transportation payments application reside on third party systems cards may be a supplement to a system operated by the transportation agencies.

- SmartAccess system, to link the expanded regional smart card system clearinghouse with the DC parking TransPass system and the Smart Tag system through a common account. This corresponds with Phase I as described in the SmartAccess proposal. Within the 3-5 year timeframe, it is assumed that Phase II of SmartAccess (involving the acceptance of the smart cards accepted by regional transit agencies with Smart Tag and TransPass as well) will not advance beyond the demonstration stage.

The following table illustrates the basic system hierarchy (although shown as separate, the WMATA SmarTrip central system, the multiple agency smart card clearinghouse and the SmartAccess central account system, could potentially be combined):

<table>
<tr><th colspan="7">SmartAccess Automatic Revaluing Management System</th></tr>
<tr><th colspan="5">Regional Transit Smart Card Clearinghouse System</th><th rowspan="2">DC Department of Public Works
–Public Parking Fees
-Some Private Parking Fees</th><th rowspan="2">Smart Tag
–Electronic Toll Collection</th></tr>
<tr><th>WMATA SmarTrip System</th><th>Local Bus Agencies
-Bus Fares
-On-Bus Revaluing
–Sales Outlet Revaluing</th><th>Commuter Rail Agencies
–Buy Advance Ticket
–Buy Ticket On-Board
–Station Revaluing
–On-Board Revaluing
–Sales Outlet Revaluing</th><th>Metropolitan Washington Airports Authority
–Parking Fees
–Revaluing</th><th>Retail Merchants
–Revaluing
–Retail Purchases</th></tr>
<tr><td>WMATA
-Metrorail Fares
-Parking Fees
–Metrobus Fares
-On-Bus Revaluing
–Station Revaluing
-Sales Outlet Revaluing</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

4.3.2.2 Capital Costs for Participating Agencies Beyond WMATA

Work recently completed for WMATA has developed rough cost estimates, for individual transit agencies to get farebox equipment for accepting SmarTrip compatible fare media (taking advantage of the current WMATA joint farebox procurement). Different levels of on-board integration are under consideration for the local bus agencies, and were priced as separate scenarios in the WMATA report:

- The comprehensive "integrated" on-board configuration would bundle an electronic registering farebox with integral readers for WMATA magstripe tickets and SmarTrip cards. A related capability would be bill validation, so that different lower-denomination bills could be distinguished and "change" provided to boarding passengers in the form of stored value on their magstripe ticket or SmarTrip card. This can provide an additional revaluing method for bus-only passengers (who might rarely get to the stored value vendor machines in Metrorail stations).
- Some agencies may not be able to justify purchasing new fareboxes (for example, if the current fareboxes are fairly new). A "stand-beside" smart card reader could be added beside the existing farebox. The card reader and farebox would not be interconnected (each would be probed separately at the garage and their revenue/ridership data would need to be merged as part of the back-office data processing). Bill validation, and the associated on-board revaluing feature, would not be available. Magstripe tickets would not be processed, only smart cards (if some agencies take this approach, WMATA could choose to only offer a bus-to-rail transfer with smart cards, which could help drive up smart card market penetration). Maryland Mass Transit Administration has indicated they will use this approach (for commuter buses).

Cost estimates for regional transit agency equipment (at local agencies most directly linked with WMATA) are summarized in the following table. Costs for Metrobus and Metrorail equipment have been left out of the estimates since these WMATA investments have already occurred or are already committed.

	Fleet Size	Agency Cost
Alexandria DASH	42	$470,000
Arlington Transit	4	$96,000
Fairfax Connector	159	$1,716,000
Fairfax CUE	12	$181,000
Potomac and Rappahannock Transportation Commission	76	$833,000
Ride On	315	$3,408,000
The BUS	101	$1,129,000
Total	*709*	*$7,833,000*

Source: ""Developing a Regional Approach to Fare Collection", Booz -Allen & Hamilton, May 2000

When "integrated" fareboxes are purchased, only the incremental cost for the additional features beyond a "traditional" registering farebox (bill validation, providing change in the form of revaluing, the magstripe and smart card readers) has been counted as part of the "regional payment system" cost. For this reason, the "stand-beside" scenario cost estimates from the WMATA study were used.

A range of unit costs was used in the WMATA study, so the mid-range cost has been used for simplicity of presentation. The estimates also include some additional agency level equipment directly associated with the on-board equipment (a device for initializing smart cards as well as a system for collecting transaction data from on-board and transferring it to a clearinghouse). Various cost allowances were

included for installation, software integration, replacement parts, project management, contingency, etc.

The following are the various capital cost components estimated for expanding on the current WMATA SmarTrip system to develop a regional smart card system (that is, not including operating costs for clearing and settlement services that have been assumed to be provided by a privately operated regional smart card clearinghouse):

Other Local Bus Agencies (purchased as option under current WMATA procurement)	$7,900,000
VRE / MARC	$500,000
Dulles Airport Parking	$50,000
Total	*$8,450,000*

Notes:
1. VRE / MARC cost does not include the costs of ticket issuing devices that are upgraded to accept SmarTrip (assumes about 120 devices)
2. Airports implementation does not include the costs of pay-on-foot devices that are upgraded to accept SmarTrip (assumes about 3 devices)

Coupled with the estimated WMATA investment of $30 million to $35 million for the overall bus/rail/parking SmarTrip system, this suggests an initial capital investment by transportation agencies of roughly $40 million.

These estimates only explicitly account for the acceptance of the WMATA SmarTrip cards by non-WMATA agencies. If other agencies also issue smart cards that are to be accepted by agencies throughout the region, the impact on the costs for regional acceptance will depend on the interoperability issues involved. If these other agency smart cards use the same contactless interface technology as the SmarTrip cards, interoperability costs would be limited to enabling the various card readers to communicate with the new card software. If the non-WMATA cards use a different contactless interface technology, more extensive retrofitting of the smart card acceptance equipment could be required. Refer to the standards and interoperability discussion in section 2.1.2 for further details on this issue.

4.3.2.3 Annual Operating Cost for Regional Smart Card Clearinghouse Transaction Fees

Preliminary clearinghouse costs were estimated in the recent WMATA regional fare collection study for a group of regional transit agencies that included all of the agencies we are considering (plus Laurel CTC). The estimates (including the initial smart card inventory) included a “start up” payment of $1.83 million and transaction fees totaling $10.57 million over the course of a five year agreement. This is indicated as corresponding to about 1.5% of the payment transaction revenue and to about 1.7 cents per payment transaction. The range of typical clearinghouse operating costs is reported as from 1.5% to 15%.

As is discussed further below, the conceptually similar TransLink system being developed for San Francisco has a private sector operating agreement that involves fees in the range of roughly 5 to 8 cents per transaction (depending on the actual transaction volumes that are realized). Also, the system being developed for the Rome region, also similar in concept, has an operating agreement that involves transaction fees at about 8% of the payment

transaction revenue.[7] If a new clearinghouse system needs to be developed for the regional smart card acceptance system, similar operating costs may be experienced.

However, comparisons with operating costs experienced with new regional clearinghouse implementations could overstate potential costs under certain circumstances. For example, there is the potential for cost savings through building on the current WMATA SmarTrip system. There is also the possibility of using a clearinghouse service that also recovers its infrastructure costs from additional customers beyond the DC region agencies (for example, if ERG/Motorola provided the services as an extension of the TransLink clearinghouse).

To further explore clearinghouse preliminary cost estimates, the annual operating cost to transportation agencies for an regional smart card acceptance clearinghouse was estimated through a comparison with the annual operating costs expected for the San Francisco TransLink system. Transaction volumes are expected to be roughly between 98 million and 293 million for the first year[8]. TransLink clearinghouse costs are understood to involve initial capital costs of $36.7 million and annual operating costs (over a ten-year period) between $7.9 million and $13.6 million (depending on actual transaction volumes)[9]. This corresponds with an overall average operating cost per transaction that varies between about 8 cents and 5 cents (decreasing as the transaction volume and overall revenue to the clearinghouse operator increase). Overall annual costs will be roughly proportional to the payment transaction volume, although there are also other types of service fees the TransLink clearinghouse operator will receive (such as load transaction fees).

To approximate the number of transactions expected for the Washington regional system:

Agencies	1998 Annual Transactions	Smart Card %	Annual Smart Card Transactions
Metrorail	157,000,000	30%	47,100,000
Metrobus	126,000,000	20%	25,200,000
Other Transit Agencies	33,000,000	20%	6,600,000
MWAA Dulles	3,100,000	5%	155,000
		Total	*79,055,000*

Note:
1. MWAA transactions based on 1998 Dulles exit volumes reported in SmartAccess proposal.
2. Transit transactions use unlinked trips from the 1998 National Transit Database, with the exception of Metrorail (for which using unlinked trips overestimates the number of payment transactions) which uses Fiscal Year 1999 ridership data from WMATA.

The market penetration assumptions used in the above analysis are at the low end of the range used in generating the projected TransLink transaction volumes and are consistent with those assumed in the recent WMATA study. The 79 million first year transaction volumes projected for the regional smart card acceptance system is about 80% of the low-end estimate of 98 million transactions for TransLink. This suggests that the annual transaction fees operating cost might be about 80% of those for the low end of the range for TransLink – roughly $6.3 million per year. If ridership and clearinghouse volumes increase in future years, the clearinghouse annual cost would increase as well.

[7] ERG press release, June 1999
[8] "TransLink Contract Book – Appendix C4: Load and Fare Payment Transaction Volume Estimates", Metropolitan Transportation Commission, January 1998
[9] Discussion with ERG/Motorola representatives – June 1999

4.3.2.4 Smart Cards

The San Francisco TransLink system is projecting that the number of cards in circulation at full deployment will be about 1 million. Given the annual transaction volume of about 100 million, this implies an average number of annual transactions per card at about 100. At first glance this might seem low, but the annual transactions per card should not be overestimated as this would lead to underestimating the number of cards required. Also, although frequent riders might use the card around 1000 times or more per year, there will also be a large group of occasional users who might use the card 50 times per year or less. Overall, the projected number of cards for San Francisco seems reasonable.

The annual transaction volume estimated for a regional smart card acceptance system is about 80% of the low end estimate for the number of transactions in the San Francisco region (see the discussion in the previous section). For this reason, the number of DC region smart cards has been proportionately estimated at about 800,000. Although there are already nearly 90,000 SmarTrip cards in circulation as of July 2000, we will assume that these cards might need to be upgraded at some point in the larger deployment (meaning that the full cost for 800,000 cards should be considered). At roughly $4 per card (this is less than the initial costs experienced by WMATA for early SmarTrip implementation, but the full-scale deployment will involve larger card purchase volumes), this leads to an overall cards cost of $3.2 million. This is the capital cost only, since ongoing replacement of cards will also be required (roughly 5%-20% per year of the circulating card volume). WMATA currently recovers $5 of the card cost (and administrative costs associated with card issuance) as an initial customer issuance fee, but the regional policy for this is still being determined so the full card cost has been retained in the costs table at this point.

4.3.2.5 SmartAccess System

The SmartAccess proposal to FTA estimates the overall costs anticipated for the SmartAccess system, primarily serving to manage "automatic revaluing", that will link the regional smart card acceptance system for transit and airport parking with the TransPass and Smart Tag systems. These costs are based on the Smart Access system being an extension of the current M-Tag Customer Service Center (operated by Lockheed Martin). Phase I capital costs were estimated at about $3.7 million.

4.4 Implications for Transportation Operations

An evolution towards this longer-term vision will have several important implications for the revenue operations of the various regional transportation agencies, including the various transit modes, toll facilities and parking:

- Introduction of a regional multiple agency smart card based transportation payments system will affect many different functional areas (fare media distribution, revenue collection, maintenance, customer service, etc.). These impacts are associated with fundamental differences in the underlying concept of operations in comparison to more conventional fare collection systems, including:
  - Issuance of a fare media to be used over a period of years rather than weeks.
  - Substantial reductions in the volume of cash to be collected.

  - The potential to completely transform the revenue collection operation into an activity based on data transfers.

- Transit fare media that are accepted throughout the region would streamline transfers, such as between Metrorail, Metrobus, commuter rail and local bus, promoting increased ridership.
- The fare policy flexibility supported by the capabilities of the transit card application will allow agencies to consider fare policy innovations that might increase ridership, such as time of day pricing.
- Cards that also support toll payments will help enable transactions with drivers who are not the owners of the vehicles, such as with rental cars and taxis (a transponder account must usually be the responsibility of the vehicle owner).
- Using the same card for multimodal transportation payments will enable customer-friendly policies, such as multimodal linked trip discounts and joint loyalty programs.
- The opportunity to pair the transportation card applications with others applications will create new marketing opportunities.
- The new system will reduce the use of a variety of elements that contribute to high operating costs for maintenance and revenue servicing, such as accepting large amounts of cash, magnetic stripe equipment, restocking paper tickets and ticket printers.
- The system will be more easily adapted to the future evolution of state-of-the-practice equipment.

5 General Migration Strategy

5.1 Overview

In addition to establishing a guiding collective vision for a regional smart card based transportation payments system, it is also essential to develop the general strategy for making the migration from current systems. Specific implementation initiatives, collectively or by individual agencies, can be created within this framework. This section will consider the objectives to be considered in deciding what to do and in what sequence to deploy overall. It will also consider the various dimensions through which the overall system will tend to expand, subsequent to a successful pilot deployment.

5.2 Objectives

This section identifies several basic objectives that could guide the general migration strategy.

5.2.1 Use Pilot Deployments

For the scale of a regional transportation payments system for multiple agencies (being a system that will introduce such fundamental changes in the underlying concept of operations for fare collection), a staged deployment is recommended. Initial limited scale deployments will help the agencies to develop essential refinements, enhancements and customizations for full-scale deployment that cannot be learned except through real-world operations.

Ideally, a pilot deployment will be a foundation upon which the full-scale system may be erected, once it has been adapted based on the practical insights gained through initial use. The staged deployment of SmarTrip in process at WMATA will most likely be that foundation in the case of the Washington region, and will certainly provide information that should help other agencies deploying in the region later. Each agency will nonetheless involve certain distinct characteristics that warrant an initial limited scale deployment in each case.

5.2.2 Build on Current Operations and Initiatives

The migration strategy should try to build on the SmarTrip fare collection system that is already in place, as well as on the planning work that has already been completed for expanding SmarTrip acceptance and developing the SmartAccess enhancements. For example, even if the existing WMATA SmarTrip management system were not being used directly as a platform on which to develop the regional smart card clearinghouse it would likely make sense nonetheless for it to be integrated into the overall system. It would in this case likely become an agency-level management system that manages the link between the clearinghouse and all the WMATA fare equipment.

The planning should also avoid requiring that existing equipment be discarded within its economic life. For example, local bus agencies might not need to replace newer fareboxes or commuter rail TVMs. There may be the opportunity to reduce the capital cost of expansion if existing equipment can be integrated cost effectively.

There can be significant constraints in the ability to integrate existing equipment and software, however, due to intellectual property restrictions with the original vendor. For this reason, individual agencies may need to time their procurements to the planned renewal cycle of their current fare collection equipment. In other words, if an agency has existing fare collection equipment that cannot be integrated to operate as part of a regional system, and the equipment is still within its economic life, one approach would be to wait to become part of the regional system until they are able to justify the purchase of compatible equipment. For some agencies, this could be several years away, so one consideration for staging could be to pursue the earlier deployments with agencies that have a planned equipment renewal in the near term. For example, MARC does not currently have platform TVMs.

Still, an underlying difficulty with this approach is that certain agencies would be required to transition (sooner or later) to a proprietary technology to achieve regional interoperability. In the DC region, agencies may not wish to limit their AFC vendor selection to the Cubic equipment that is currently established with the WMATA SmarTrip system (or their procurement regulations may not permit them to do so). For example, the recent VRE AFC procurement has not limited itself to considering Cubic equipment for the sake of ensuring the easy achievement of interoperability with the WMATA SmarTrip system.

A preferable situation would be if each agency could procure equipment in a competitive environment, with the various proprietary technologies involved collaborating to allow an interoperable system to be developed in a manner that still protects the intellectual property of each vendor. In some cases, this might involve the development of special-purpose interfacing hardware/software devices that accomplish the integration between disparate proprietary equipment without the vendors needing to reveal any proprietary information to each other. In this type of approach, vendors only need to reveal their proprietary information to the developer of the interface equipment. Two specific examples of this approach are:

- When the Chicago Transit Authority needed to integrate new magnetic stripe card readers from Cubic with existing electronic registering fareboxes from GFI (while the Cubic AFC system was being implemented in 1997), it became necessary to developed specialized interface equipment.
- A current effort to integrate the smart card readers supplied by Motorola, for the TransLink regional AFC system in the San Francisco Bay area, with the existing Cubic faregates in Bay Area Rapid Transit (BART) stations is understood require a specialized embedded control system developed by a third party vendor.

5.2.3 Market Segment Priorities

The sequence in which individual deployments are staged within the overall migration path can take advantage of insights about market segments that the agencies could target for ridership gains. As discussed previously, commuters, students and occasional users for shopping/entertainment could perhaps receive incentives through the additional capabilities of a multiple application smart card based system. It could be useful to target early deployment on agencies and services that are oriented towards use by some of these market segments.

5.2.4 Early Benefits

It will help if the earliest deployments show measurable benefits. This will not only serve to vindicate the selection of new technology over the status quo, but can also be used to build political support and funding for the complementary deployments at other agencies that will work together to build towards the overall regional multimodal payments system.

The WMATA SmarTrip deployment has been achieving good results in terms of the number of cards issued. Now that the cards can be used throughout Metrorail and parking facilities, WMATA is providing information to the press and increasing the public visibility of the initiative. The intent is to further build public demand for using SmarTrip.

The linked challenge is to ensure that the agency can avoid a backlash in opinion if the pace of deployment cannot keep up with expectations. This occurred to varying degrees in several recent electronic payment system implementations, including the E-ZPass and MetroCard implementations in the New York City region and the Octopus smart card system in Hong Kong. In the case of the expansion of WMATA SmarTrip acceptance, the challenge might show up in the form of unexpectedly high public demand for using SmarTrip beyond Metrorail/parking.

Several of the benefits associated with this type of system are difficult to clearly demonstrate until customer smart cards are accepting by agencies throughout the region. Since the initial deployment in the DC region involves only WMATA, it will be important to highlight the future multiple agency benefits that are being enabled by the initial system. This would be one of the opportunities to benefit from having developed a high-level vision and general migration strategy that can be shared with the general public. The challenge will be to present future expansion plans and longer-term value-added capabilities in a way that manages public expectations and avoid backlash over "delays" in full system development.

5.2.5 Funding Sources

The amounts and timing of capital funding availability at the various agencies, as well as the willingness to consider innovative funding and procurement strategies will influence the order in which agencies are in the financial position to undertake the deployment of fare collection system enhancements or replacement. These considerations can also affect choices about when procurements should be undertaken by one agency on behalf of another. This can involve issues such as the timing for upcoming bond issues, flexibility in the allocation of available user fees and opportunities to leverage state or federal grants.

5.2.6 Adaptability

Early deployments should avoid placing undue constraints on the ability to incorporate lessons learned into the overall system or to otherwise adapt the evolving system to address new opportunities, changes in technology, etc. Initial investments in procurement measures that secure this flexibility can later pay substantial dividends.

For example, early selections of smart card technology could be superceded by the evolution of standards; it may become more desirable to enable the acceptance of future smart cards that use a different technology than that originally deployed. Alternatively, others may later

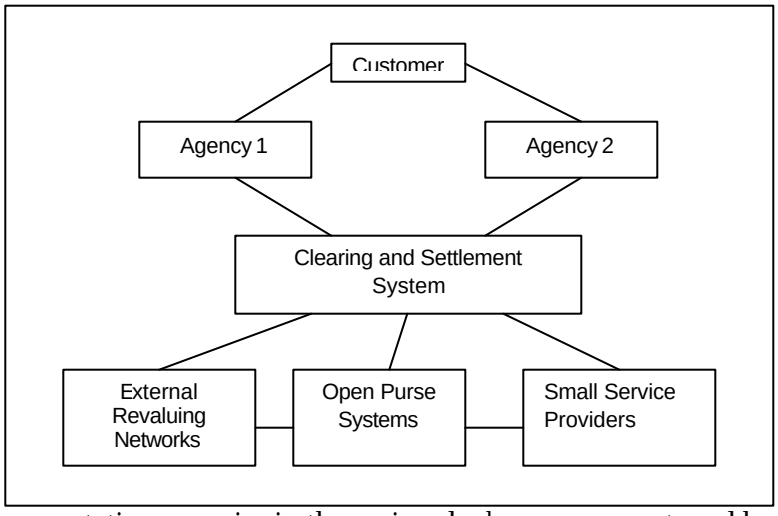
issue smart cards that use a different technology and it may be desirable to simultaneously accept both the new and the original payment media.

5.3 Routes of Expansion

The overall migration path will combine system adaptation to changes in technology (or to the understood user requirements) with various types of expansion.

5.3.1 Agencies Involved

Figure 5: Centralized Clearinghouse Alternative

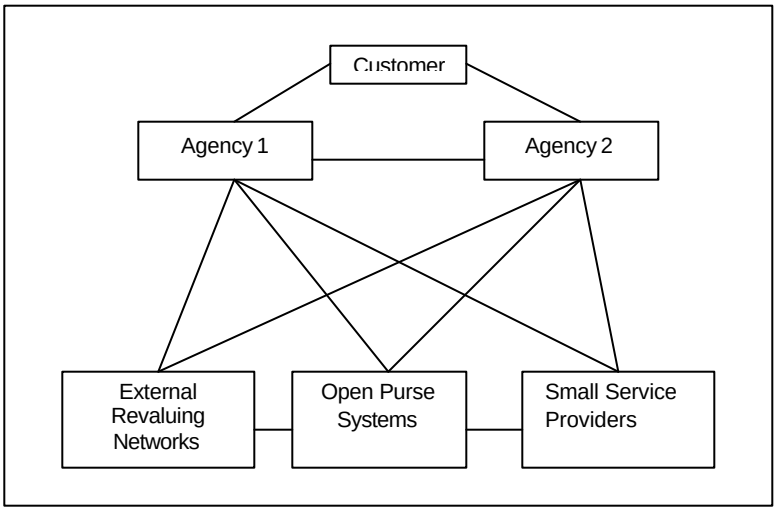


As multiple transportation agencies in the region deploy some smart card based payments equipment, the central system will need to take on the role of a clearing and settlement system. The central system functionality will need to shift from simply tracking charges within a single agency against prepaid funds also held by that agency, to assuming responsibility for settling the value of transactions with one of several systems. The transformed role of individual agency systems would likely include:

- Retaining and administering revenue from the purchase of agency-specific prepaid fare products (such as passes).
- Collecting fare payment transactions for submission to the clearing and settlement system.
- Reporting and setting new fare policy parameters.
- Support for agency-operated infrastructure for card issuance, revaluing and customer service.

A clearing and settlement system can take either a centralized or distributed model. With the centralized model, a single agency or jointly controlled organization holds all the prepaid funds. For a decentralized clearing system, each agency holds funds it collects and there are periodic transfers between agencies to reflect any net differences in the claims each agency has on the other. Alternatively, a third party centralized clearing and settlement system can be established.

Figure 6: Decentralized Clearinghouse Alternative



There may be some types of service providers that do not set up any kind of central system or cardholder support infrastructure of their own. For example, a small parking operator may be likely to limit their smart card related administration to simply tracking the amount of their daily smart card sales, for reconciliation with the daily settlement received from the clearing and settlement system (similar to the way they might administer credit card sales).

For the participation of Smart Tag or regional E-ZPass toll collection agencies, decisions will be needed about the role of the existing Customer Service Centers (CSCs) in the overall system. The fundamental role could be similar to the new role discussed for agency-level systems. In addition, if the use of transponders without smart cards continues to be an option, there could be a mixture of account types. “Transponder” account holders would be administered by the toll collection system in the same way the current accounts are handled. “Smart card” account holders would be administered as part of the larger regional multimodal system.

The SmartAccess proposal for the DC region involves a distinct system for clearinghouse functions related to the automatic revaluing of accounts and transferring such value to the various regional electronic payment systems (regional smart card system, Smart Tag, TransPass and any others that might develop). This capability could of course be part of the regional smart card clearinghouse (or part of any of the other systems involved, for that matter).

In addition to the automatic revaluing feature, SmartAccess could also mean that transactions completed at a revaluing device in the regional system could also serve to revalue accounts with any of the other payment systems linked through SmartAccess. For

example, a single transaction at a Metrorail revaluing machine could add value to the smart card stored value balance as well as to that customer's Smart Tag and TransPass accounts.

For the near to medium term in the DC region it seems likely that smart cards might only be accepted by the region's transit agencies (and MWAA parking), and the SmartAccess system provides a reasonable approach to offering a common revaluing mechanism with the Smart Tag and TransPass systems.

5.3.2 Agency Fare Collection Infrastructure

Some agencies might not initially equip all of their services for smart card based payment. One type of agency-level expansion would be to focus further development within a single mode:

- With Metrorail SmarTrip, for example, the initial system only equipped a limited number of faregates in at each station entrance. The WMATA deployment is also staged by mode, with Metrobus implementation held off until after the initial Metrorail-based system was established.
- The logistics of staged deployment within an overall agency bus fleet can be more difficult to arrange, since the agency needs to indicate to the public which routes accept smart card payments. Unless a relatively small fleet of buses is dedicated to certain routes, offering the service only on selected routes might require many different buses to be equipped. In practice, this usually means staging the bus deployment by groups of routes and vehicles operating out of individual garages.
- A toll road agency might initially equip only selected toll facilities and selected lanes.

5.3.3 Revaluing Infrastructure

The level of market penetration for smart card based payments in the region will likely correlate fairly closely with customer convenience for revaluing cards. The revaluing infrastructure will expand as additional agencies become participants and as those agencies accept smart card payments for a broader range of their services. In addition, each agency can choose to deploy more revaluing service points to promote increased market penetration.

If there were a centralized clearing and settlement system, revaluing service points would most likely be its responsibility. Agencies would in many cases operate these service points since customers have such direct access to agency facilities (for example, revaluing through TVMs and customer service facilities). The clearing and settlement system would also likely establish an array of additional revaluing infrastructure that it would operate directly, or arrange to have operated on its behalf by a variety of other third parties. For example, this might involve revaluing through retail establishments, Automated Teller Machines, the Internet, telephone-based services, etc. These types of geographically distributed revaluing networks are of particular importance with bus smart card acceptance since agency operated facilities in rail stations and transfer centers might not be readily accessible to many bus customers. With a distributed clearing and settlement system, such third party revaluing networks would be affiliated with the systems operated by the agencies.

5.3.4 Capabilities

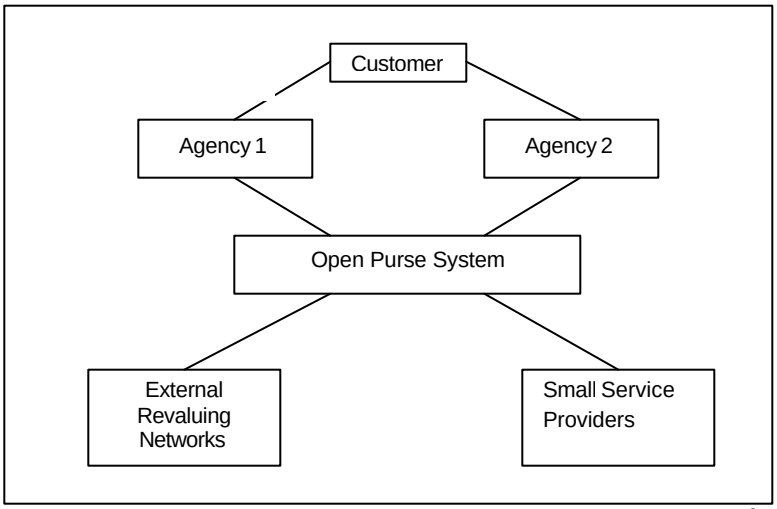
There is considerable scope for ongoing expansion, in the potential range of uses for the smart cards. Beyond using a smart card for payments with various transportation services, certain non-transportation service providers (such as retailers and pay phones) might eventually accept these cards.

With the Hong Kong Octopus system, the card came to be in regular use by so many citizens that tremendous interest emerged from non-transportation services (especially near major transit facilities) in accepting the card. The centralized clearing and settlement system is controlled jointly by the transportation agencies (through the Creative Star organization) rather than by a financial institution, but this has not stopped Creative Star from pursuing these opportunities to collect additional transaction fees.

5.3.5 Non-Transportation Partners

An open purse system (such as Visa Cash or Mondex) might be used as the centralized clearing and settlement system. Or, payments from one or more of these open purses might be accepted as complementary payment options to the system's purse. Under these scenarios, there would be more card uses. This would likely involve card use with an increasing variety of stores and Internet retailers, as the open system achieves increasing market acceptance. As the range of card services increases, the cards could become more highly valued by customers and this may help increase market penetration for transit use.

Figure 7: Open System Linkage Clearinghouse Alternative



The non-transportation applications would provide additional card uses for customers. For example, if there are employer or university card applications available on the same card with a transit application, some might originally get the card for non-transit purposes and eventually decide to try transit (perhaps with some incentives created through joint marketing).

6 Logical Architecture

A logical architecture identifies various individual logical functions within an overall system as well as the information flows between these functions and system users. A logical architecture accommodates many possibilities for the system design specifics.

The next design step that builds on the logical architecture is often a physical architecture, which allocates the logical functions to various physical devices and identifies the information flows between devices and customers (this in turn supports the development of device and software specifications).

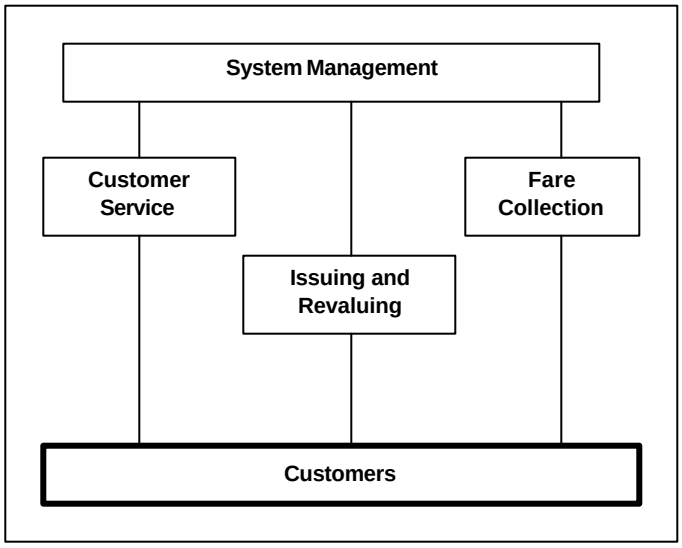
Individual logical functions often encapsulate a subsidiary logical architecture of sub-functions, internal information flows and information flows with external functions. This hierarchical approach to logical architectural functional decomposition only needs to be sufficiently broken down to support the later step of allocating individual functions to physical devices.

The following diagrams present a logical architecture for a multiple agency system. The initial logical architecture diagram, referred to as a context diagram, illustrates the relationships between customers and the most fundamental system functions. The others, referred to as subsystem diagrams, address the next level of logical architecture decomposition for each of the fundamental system functions from the context diagram.

6.1 System Context Diagram

At the most fundamental level, the system can be logically visualized as using four functions to support transit fare collection. Three of these functions are used by the customer, through smart card transactions as well as through interaction with self-service devices and agency staff. The system management function supports each of the other three functions through a data management system, funds transfers and the distribution of cards.

Figure 8: High-Level Logical Architecture

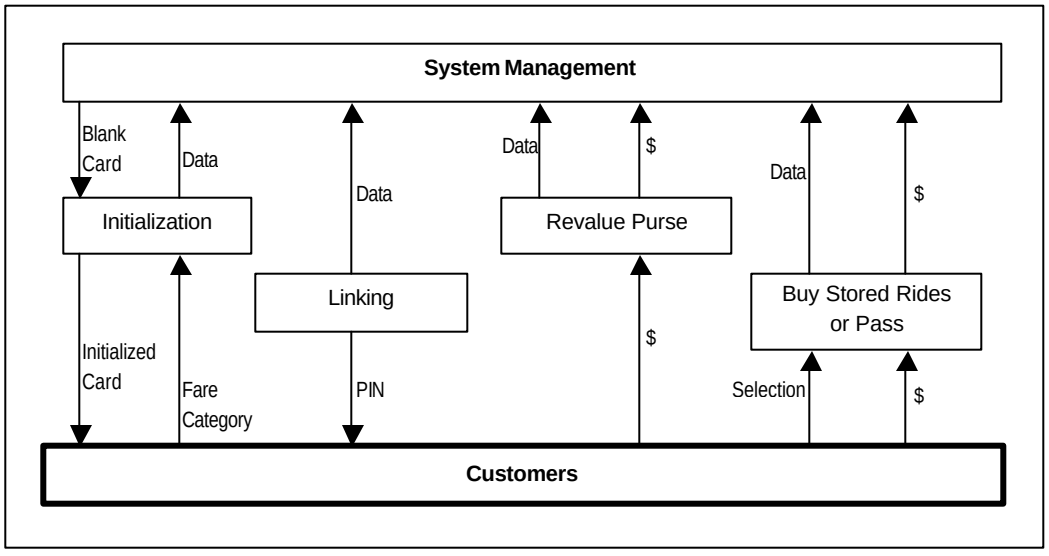


6.2 Subsystem Diagrams

6.2.1 Card Issuing and Revaluing

- **Initialization:** Customers get a smart card by identifying their fare category, which is then encoded on a blank card. Although not shown as essential, it most cases the customer would be required to purchase or provide a deposit for the card.
- **Linking:** Customers provide information, either at the time of issuance or later, which would allow the card they had held to be identified even if lost or stolen. There is often also the option for a cardholder to not link their card and remain anonymous to the system. As will be discussed under the customer service function, linking can support features such as card blocking and stored value replacement. In this case, the approach of providing the customer a secret Personal Identification Number (PIN) is shown, which allows the personal to retain anonymity. An alternative approach is for the customer to register the card to their name. Card linking can also be used to enable remote customer service requests (for example, by telephone or email).
- **Revalue Purse, Buy Stored Rides or Pass:** Periodically, the customer would make a prepayment to increase their stored value balance, increase their stored rides balance or purchase a pass equivalent. A transaction record would be stored on the card and forwarded to the management system at the earliest opportunity. If the transaction is paid using a credit or debit card, the transaction would need to get an on-line authorization from the issuing financial institution system.

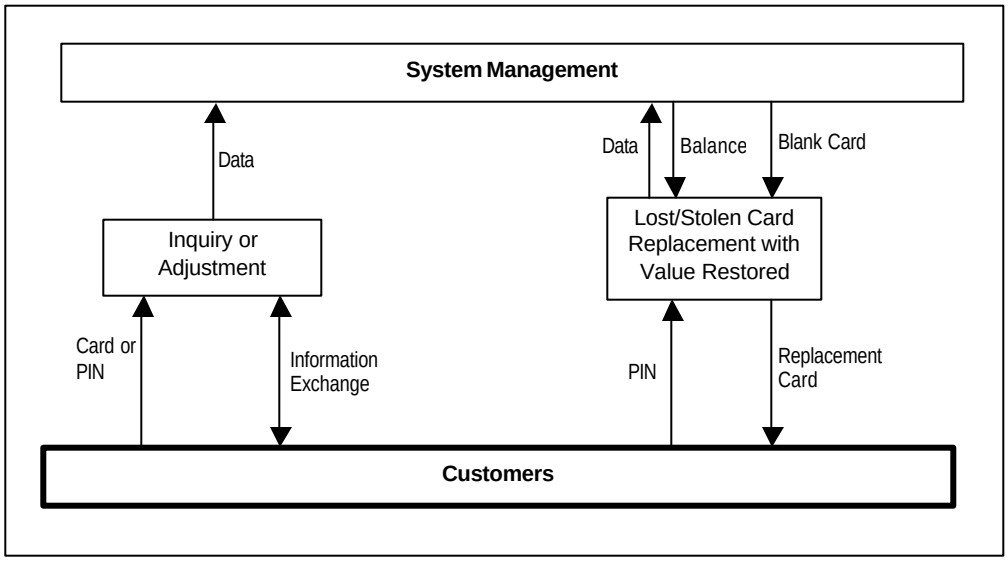
Figure 9: Issuing and Revaluing Subsystem



6.2.2 Customer Service

- **Inquiry or Adjustment:** At a customer service location, the card can be presented, while customer service over the telephone or email would require use of the PIN or other card identifying information. A range of capabilities could be provided, including questioning the validity of the current card balance, changing the card configuration, etc.
- **Lost/Stolen Card Replacement with Value Restored:** If the customer needs to replace a lost or stolen card and does not have any means to identify the card which had been held, the card issuance function applies. With a PIN or other card identifying information, the original card can be blocked from further use and the correct balance can be retrieved from the system and restored on a replacement card. Recently completed transactions would not yet have been retrieved by the system, indicating that the value restoration should be delayed or a correction to the balance made at a leter time.

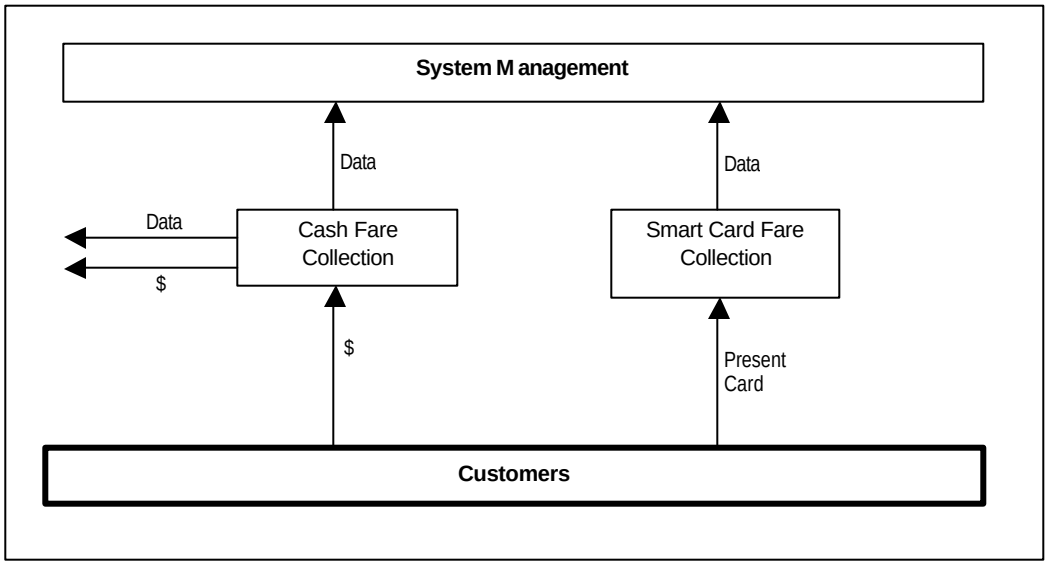
Figure 10: Customer Service



6.2.3 Fare Collection

- **Smart Card Fare Collection:** By presenting the smart card at a faregate, farebox or ticket vending machine, the data on the card can be checked and the correct fare automatically determined and deducted from the card. Feedback would be provided to the customer as well as to any agency staff overseeing the transaction. A fare record would be stored on the card and also provided at the earliest opportunity to the management system. There might be other actions required as well, such as opening a faregate or providing a ticket.
- **Cash Fare Collection:** Cash (and perhaps other "conventional" fare media) will likely still be accepted. The collection of cash and the associated data would likely continue to use the conventional revenue collection systems that currently exists. However, the transactions data can also be provided to the smart card management system so that consolidated revenue and ridership data can be compiled.

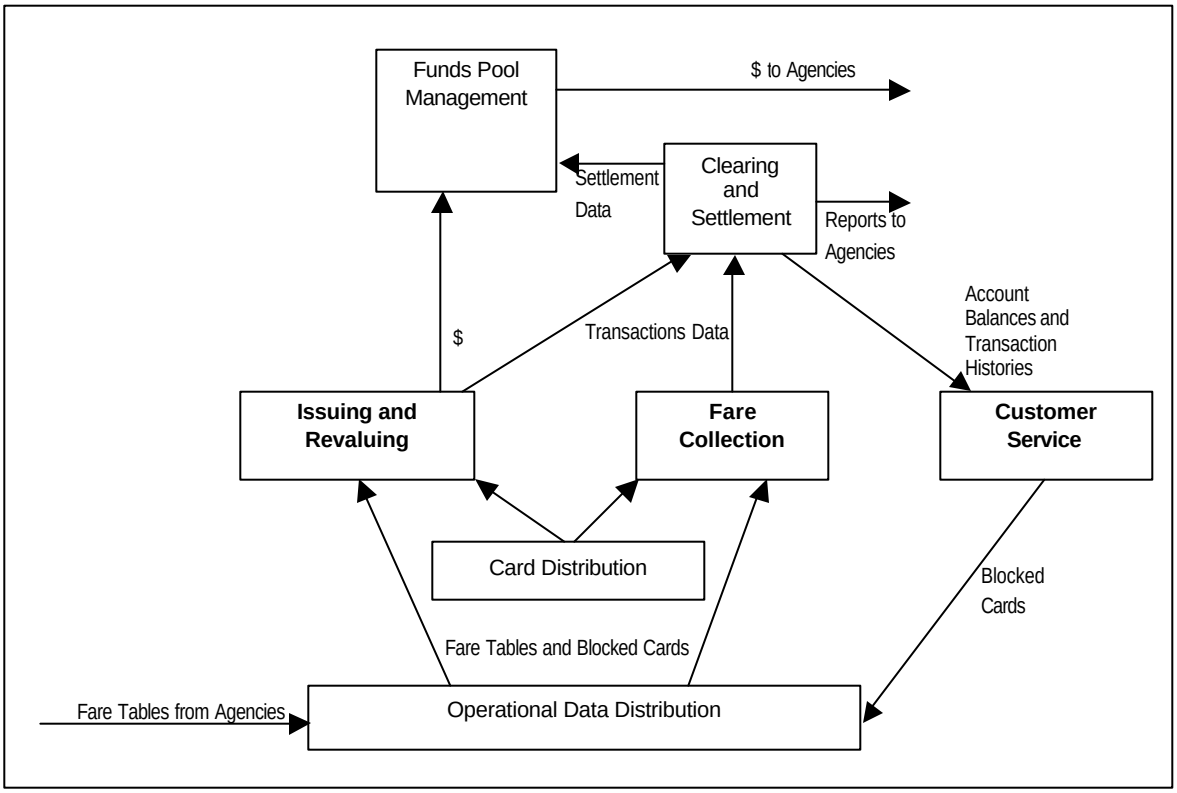
Figure 11: Fare Collection



6.2.4 System Management

- **Funds Pool Management:** Funds received from revaluing are held and managed, pending settlement. These funds would be under the responsibility of either a central organization or of individual agencies, depending on whether a centralized or distributed clearing and settlement system was involved. In either case, the funds would be invested and held in one or more accounts by financial institutions.
- **Clearing and Settlement:** This function maintains databases of issuance, revaluing and fare payment transactions. All of these transactions are reconciled, likely on a daily basis, in accordance with accepted accounting principles and to help spot fraudulent activity. This is the "clearing" of transactions. The transactions data are also used to determine any funds owing to or from individual agencies, which is the "settlement" process. Funds transfer is enabled through providing settlement instructions to the funds management function. Customer service can access these databases to gather card balances and transaction histories that are needed to support its functions.
- **Card Distribution:** The management system would also provide a consolidated function for procuring smart cards, to help ensure consistency and economies of scale. These cards would be distributed for use in the card issuance and replacement functions.
- **Operational Data Distribution:** The smart card fare collection and revaluing functions need to receive updates on fare tables generated by agencies as well as on blocked card lists from customer service.

Figure 12: System Management



7 Deployment Challenges and Issues

7.1 Challenges

7.1.1 Establishing a Collaborative Decision Making Process

WMATA has made a great deal of progress in implementing the SmarTrip system and in creating the basis for other agencies to participate in an expanded multiple agency system that builds on SmarTrip. Transportation agencies currently collaborate through a variety of mechanisms, including organizations like MWCOG and NVTC, as well as various less formal means (such as the recent collaboration on developing the SmartAccess proposal and the Fare Technology Working Group that has been initiated by WMATA). The Fare Technology Working Group is currently serving as the de-facto collaborative organization for developing a jointly governed regional electronic payments system.

A regional electronic payments system will be a significant undertaking that will take several years to complete. A collaborative organization with a more formal mandate and with agreed ground rules could be established as an outgrowth of the Fare Technology Working Group, along the lines of the E-ZPass Inter Agency Group or the I-95 Corridor Coalition. This new organization might be established under the umbrella of an existing regional body such as MWCOG or it might be constituted as a completely new organization. Regardless, to achieve success it would need a clear mandate and dedicated resources as well as willing participation and support from agencies.

An Executive or Steering Committee might set collective direction on matters where communal action is necessary, and Working Groups or Task Forces might be developed to coordinate the required work. A formula would be needed to govern funding contributions for the activities of the organization and any outside resources brought in to help accomplish its ends.

Such an organization will not spring up overnight, nor is this essential. The first step is for more ad-hoc collaborative activity between agency representatives, as an extension of the collaboration that is already occurring through the Fare Technology Working Group, to establish the fundamental aims of the organization and to agree on a basic longer-term vision. Once formation of the organization is formally sanctioned and funded, the representatives can begin the practical efforts to organize and execute a program of work. As these practical efforts proceed, the most effective organizational structure will become increasingly clear over time.

A fundamental shared vision will need to be the driving force behind the successful launch of this initiative. The shared vision must create enthusiasm with the promise of significant value added over the status quo. Key features could include:

- Retaining the policy autonomy of the individual agencies while creating exciting new fare policy opportunities
- Support for coordinated loyalty/incentives programs

- Enabling partnerships that enhance customer convenience and improve the business case

One of the earliest things such an organization would need to accomplish is building on the accepted longer-term vision to develop a migration plan. Individual agencies would program the deployments that would build the system within the framework of the vision and the migration plan. The earliest deployments at particular non-WMATA agencies would likely be pilot programs carefully designed to:

- Collaborate with the WMATA SmarTrip program
- Be cost-effective and quickly deployed
- Create early benefits and build political support
- Build on existing capital investment and infrastructure
- Create a foundation for expansion and adaptation
- Highlight opportunities for fine-tuning the vision and migration path

7.1.2 Achieving Regional Interoperability

One of the fundamental issues for coordinated deployments with independent agencies that expect to accept a customer's single payment device is to agree on how to achieve interoperability with the smart card equipment of other agencies in the region. All agency card readers must be able to communicate with all cards carrying the transportation payment application.

In the case of the E-ZPass toll collection systems, the Inter Agency Group chose to agree on the transponder/reader technology before any equipment was procured. Since there was no industry standard (there is still none), this required that a particular common vendor be selected. However, by procuring the systems integration separately, the agencies ensured that (although it would be an expensive undertaking) it would be feasible to switch to a new vendor if required.

With smart cards, the situation is marginally less restrictive than was the case for transponders at the time of the E-ZPass technology selection. Several different card and reader vendors conform to certain contactless interface technology standards (ISO 14443 Types A and B). If all cards and readers adopt one of these standards, achieving interoperability could be simplified.

However, the standards only address the communications link. These standards do not address the communications protocol, command sets and security mechanisms that allow software in the card to complete a transaction with software in the reader. In addition, the reader software needs to be integrated with an overall management system. In short, while the use of a contactless interface supported by multiple vendors is a prerequisite to having multiple supplier options for cards and readers, there are many other issues that make achieving true multiple vendor flexibility for the overall system much more challenging.

If the various agencies choose to procure cards and readers that are not compatible, achieving interoperability will be somewhat more complex. It could become necessary, for

example, to use card readers that can accept multiple card types or to actually integrate additional types of card readers into the fare collection equipment. Section 5.2.2 discusses how some other smart card systems implementation efforts are dealing with this issue.

7.1.3 Multimodal Integration

A certain level of multimodal integration can be achieved through the ability for customers to use their smart card with different transportation services. For example, customers could use the same card at the Park and Ride lot and for transit, as has been implemented at WMATA already.

As discussed in the following sections, extending smart card acceptance into the Smart Tag and TransPass systems introduces several complications. Understanding these, the agencies developed the SmartAccess proposal. SmartAccess defers the use of regional transportation smart cards with Smart Tag and TransPass, but introduces a regional system to support a central account for pooled prepayments which can then be in turn distributed to the SmarTrip, Smart Tag and TransPass systems as allocated by the customer.

7.1.3.1 Toll Roads

Integration with drive-through toll collection operations, however, introduces additional complexity since the smart cards cannot be used directly with smart card readers. Instead, the smart card needs to work through the longer-range wireless communications interface of the toll collection system transponders, which will require extensive collaboration with Mark IV (the sole vendor of transponders used by the Smart Tag and M-Tag systems). The existing Smart Tag and M-Tag Customer Service Centers would need to be interfaced with the regional clearinghouse, so cooperation will also be needed with the various systems integrators (Transcore for Smart Tag and Lockheed Martin for M-Tag).

Touch Technology International (TTI), a smart card systems integrator, has been involved with Mark IV in developing a new type of Mark IV transponder that can accept smart cards. These companies announced the resulting "Smart Fusion" product in May 2000. Although the details are not known, it is understood that TTI has an agreement with Mark IV that provides certain rights to TTI regarding the product and its deployment. There could, for example, be certain limitations on the types of smart card technology that the Mark IV transponders could support and the types of smart card transaction processing systems toll agencies can work with.

Mark IV and TTI demonstrated the Smart Fusion transponders in June 2000 for fifteen E-ZPass agency representatives, at the Palisades Parkway toll facility in the New York City region[10]. As part of this demonstration, various smart cards "issued" by the different agencies completed test transactions – both toll transactions operating through the Smart Fusion transponder as well as direct smart card payments with a stand-alone contactless reader (to represent transit use of the same card). The TTI back office system settles a transaction to the agency accepting a smart card based transaction, regardless of which agency issued the card. The interface between the smart card and the transponder uses a

[10] Presentation by Don Gleason of TTI - International Parking Institute seminar in August 2000.

contact interface, but dual interface smart cards would be used if the same card must be used with contactless interface applications such as transit.

The Smart Fusion system operates, relative to a conventional E-ZPass installation, by adding additional plaza reader equipment and by linking the agency toll system with the back office TTI smart card transaction processing system. The additional reader equipment uses a longer-range communications method to interrogate Smart Fusion transponders as they approach a toll plaza. If there is a smart card inserted, the smart card toll payment transaction is completed as the vehicle approaches the plaza. Once the vehicle enters a toll lane, conventional shorter-range communications between the lane readers and the transponder is initiated. If a smart card transaction has not already been completed, the toll system account is debited in the conventional E-ZPass manner. Smart card transactions would be periodically transmitted to the TTI back office system for settlement.

In the longer-term, the region's toll collection systems will eventually need to be renewed. For example, the Dulles Toll Road was implemented in 1996 and once its transponders have been operating for 8-10 years most will have low battery power and require replacement. It is conceivable that the Mark IV technology could be replaced with equipment from another vendor as part of this renewal cycle, which would affect the smart card integration prospects.

Mark IV, SIRIT and Amtech are the dominant suppliers in the current transponder marketplace, which focuses on the 902-928 MHz radio frequency band, but there are several emerging technology trends challenging their dominance in Dedicated Short Range Communications (DSRC):

- The current band is unlicensed and the level of interference is increasing. Also, higher frequency communication bands offer higher data rates. The Federal Communications Commission (FCC) has now allocated the 5.85-5.925 GHz band to ITS uses and efforts to manage and coordinate use of this dedicated radio frequency spectrum have begun.
- In 1999, a consortium of wireless communications industry companies developed and published the royalty-free standard for short-range (10-100 meters) communications known as Bluetooth, using the frequency hopping spread spectrum technology originally developed by the military. This is "DSRC" coming in from outside the ITS industry, focused on enabling temporary direct communication with personal mobile devices (mobile phones, "Palm Pilots", etc.). Many applications will involve payments and the emerging Bluetooth devices may often be designed with an integral smart card interface. If these devices and applications develop strong market penetration over the next few years, many people might have a potential toll transponder in their pocket before ever setting up an electronic toll collection account. However, Bluetooth might in practice complement rather than replace the DSRC transponder-roadside link, by providing an alternative to smart cards in transponders. For example, a Bluetooth enabled "wallet" in the driver's pocket could incorporate a smart card reader and use the Bluetooth wireless link for communications with the transponder on the windshield.

7.1.3.2 Parking

Integration with the DC DPW TransPass system also poses some complexity. The previously installed on-street Duncan parking meters were supplied with a contact smart

card interface suitable for use with a proprietary parking smart card system available from Duncan. Any SmarTrip card will require a contactless interface for transit use:

- The current SmarTrip cards would require that the smart card readers in these Duncan meters be replaced with readers equipped for the Cubic contactless interface. Such discussions between Cubic and Duncan are apparently in process, but are inevitably complicated due to the sharing of intellectual property usually required for such integration (refer to section 5.2.2 for a discussion about the approach some implementation efforts have taken to dealing with this type of issue).
- Another possibility is the adoption of a SmarTrip card that supports a dual interface allowing the same stored value to be used for both transit and parking meters.

7.1.4 Identifying "Win-Win" Business Case

A complex challenge associated with any initiative involving multiple participants is that the effort would rarely proceed unless every participant has something to gain. There will be a large number of different participants, so the requirement could be referred to as an overall business case that is "win-win-win-…" There is not really any overall unified business case, but rather the combination of the individual business cases for all the participants. To reach a viable joint conclusion to proceed, each party needs to be able to sincerely consider the perspective and requirements of the other parties and be willing to consider reasonable concessions that are essential to create the basis for participation by each key player.

The complexity is increased by the diversity of the participants involved – consumers, transportation agencies, partner application providers, card issuers, reload distributors, equipment vendors, systems integrators, system operators, investors, etc. These parties are so diverse that the term business case does not always even have the same meaning in the various industries involved. There is limited real world experience with the actual benefits and costs of these types of systems. Also, some benefits and costs cannot be easily quantified so any positive business case conclusion is usually a tentative one that will continue to be reassessed as time passes and there is experience with the actual benefits and costs.

7.2 Issues

7.2.1 Institutional

The following are the main types of institutional issues:

- **Planning the New Collaborative Organization:** Many of the undertakings of a regional electronic payments system will be a collective effort of the various autonomous agencies involved. Once the details of what needs to be jointly accomplished become defined, certain fundamental decisions need to be made about how this will be accomplished organizationally. Approaches can range from designating one agency to provide these services on behalf of all, to creating a new jointly governed agency organization, to outsourcing the joint operation. For the outsourcing approach, it is still necessary to establish how the outsourced effort will be managed and by whom. Important topics include business structure, ownership, capital funding and the allocation of ongoing revenues/costs. The agency representatives in the Fare

Technology Working Group have already begun to explore these issues and the new organization should build on this foundation.

- **Organizational Impacts at the Existing Agencies:** Regardless of how the new joint responsibilities are addressed, each of the participating agencies nonetheless will be affected. The effects of an electronic payments management system will cut across organizational boundaries within each agency, involving diverse functions such as finance, operations, maintenance and planning. It will be important to anticipate the types of changes to "how things work here" that will need to occur for the new techniques to have their intended effects, including what types of barriers may need to be addressed.
- **Initial Smart Tag Reluctance to Pursue Smart Card Acceptance:** Initial discussions indicate that there is little initial Smart Tag interest in being able to accept a regional smart card for toll payment. Smart Tag has indicated that their overriding objective is to continue increasing the percentage of transactions that are completed through transponders. This suggests that compelling arguments for Smart Tag participation would be those demonstrating that there are market segments which are currently resisting transponder adoption but that might be influenced to adopt a transponder if it allowed them to use the regional smart card. Substantial market research may be required to answer this question. One opportunity might lie where there are several different drivers for the same vehicle and the vehicle owner wants the driver to pay the toll directly (for example, taxis and rental cars). An even more substantial opportunity may be customers who will be using the smart card for transit as well as park and ride, but will drive on a toll road in the initial part of their trip. These customers may value the opportunity to avoid keeping track of two distinct prepaid accounts.

7.2.2 Technical

The technology to enable electronic transportation payments is fairly well established and has now been used for this purpose in real deployments. However, several issues need to be considered in how the technology will be implemented. These arise primarily from the reality that the complete system cannot spring into existence fully born and self-sufficient:

- There are existing technologies in use by the participating agencies whose capabilities need to be built upon.
- The system must be created in stages that build rationally upon one another both functionally and geographically, that are consistent with funding constraints and that create early demonstrable benefits.
- As time passes, changes in the vendor marketplace and in de-facto technology standards may change the technology that best suits the functional requirements and can be best supported. Open systems architecture must be planned from the outset to ensure that the system can be adapted as required and that the agencies cannot be captive to the offerings of any one vendor.
- Agencies might not use compatible equipment and opportunities might emerge to carry the transportation application on cards issued by other organizations. To create a flexible system, the card readers should be adaptable to the fact that there is currently no single

standard for the contactless communications interface between the cards and readers. If a card issuer uses a different contactless interface, the readers may need to be adapted.

Federal funding support may in the future become increasingly dependent on demonstrated conformity with various designated standards which are currently only emerging. Examples include:

- **ITS National Architecture:** An overall framework for the use of advanced technology in transportation
- **National Transportation Communications for ITS Protocol (NTCIP):** Focusing on the transfer of data between central systems and field components, including as a subsidiary effort the Transit Communications Interface Profiles (TCIP) which cover back-office systems and the links with on-board systems. TCIP may be influenced by a related effort, under ISO 14904, that is focusing on data structures and communications between participants for Electronic Fare Collection systems.

7.2.3 Customer Acceptance

There are certain issues that will be fundamental to success because they relate to customer acceptance:

- **Multimodal market:** The toll road agencies indicate that they have seen no evidence that accepting a regional transportation smart card through their transponders will help them with their fundamental objective of maximizing transponder market penetration. It is not clear to what extent those who drive on the toll roads and do not use a transponder would be influenced to do so by being able to pay tolls using a card that can also be used to pay for transit and perhaps parking. For example, Dulles Toll Road has not seen any market research assessing:
  - The extent to which those who use or do not use Smart Tag also use transit in their commute (and use or do not use SmarTrip)
  - Attitudes affecting whether a smart card that could be used with Smart Tag systems would influence more customers to adopt Smart Tag
- **Privacy concerns:** Some have raised concerns about the extent to which these types of systems could be perceived as involving a loss of control over what personal data is collected and for what purposes it is used. Initiatives should anticipate likely public concerns and identify approaches to address them.
- **Loyalty/incentives programs:** Any time a new approach requires customers to change their behavior, customers must at least try the new method and receive some ongoing benefits so that they will continue to use it. Customers need to receive some combination of new capabilities, improved convenience and reduced cost.
- **Convenient revaluing:** One challenging aspects of achieving a convenient smart card based payments system is to establish an extensive revaluing infrastructure. Strong market penetration requires customer convenience for replenishing their stored value balance, or otherwise updating the card configuration to allow its ongoing use.

8 Procurement, Financing and Business Structure Approaches

There is a complex array of possible approaches to procuring and financing the costs of the equipment and support for an integrated system. Similarly, various types of business structure models have been used in regional smart card efforts elsewhere.

8.1 Procurement Options

The basic procurement options can be summarized as follows:

- **Each agency selects its own system/technology independently** - This is the traditional procedure (i.e., in a non-coordinated system). Because of differences in vendors' card technologies, this approach is less likely to result in compatible systems. For example, the smart card technology selected by Amtrak is not compatible with the current WMATA SmarTrip technology. If agencies choose incompatible systems, an interoperable card solution might still be achievable, but would require one of the following approaches:
  - Retrofitting all card readers to communicate with all the different card types
  - Installing multiple card readers at each agency
  - Adopting one agency's card as the regional standard, with other agencies ultimately replacing their cards and readers
- **Agencies agree to a common technology standard, with either joint or separate procurements** - As with E-ZPass, the agencies would first agree on a common technology standard. All of the participating agencies could then conduct a joint procurement. Alternatively, each agency would procure equipment on its own timetable. The E-ZPass agencies developed common technology standards for both the transponders and for the methods the independent systems would use to settle accounts with each other.

  The current WMATA farebox procurement is creating the option for local bus agencies to purchase magstripe and/or smart card readers that would be compatible with those being procured by WMATA for Metrobus. The farebox procurement also requires the Metrobus equipment to achieve compatibility with Metrorail. Although WMATA has installed Cubic equipment for Metrorail and parking, the use of Cubic equipment for Metrobus is not mandatory. The procurement makes clear that there is intended to be a common technology standard throughout WMATA operations, determined through the farebox procurement, as well as with any other agencies that adopt the WMATA standard for their smart card equipment. However, since the procurement requires interoperability between Metrobus and Metrorail equipment, it seems that a vendor intending to replace the current Cubic role in the SmarTrip system would need to be willing to replace the current Metrorail AFC system as part of their offer. If other agencies issue smart cards that are not compatible with the equipment acquired through the WMATA fareboxes procurement, these cards could not be used with "WMATA standard" fare collection equipment unless such equipment was modified.

8.2 Financing and Business Structure Models

Several fundamental questions must be resolved in establishing a coordinated regional fare system:

- How will the system be organized and operated; what are the specific roles and responsibilities of each participant in designing, implementing and managing the program?
- How will the program be financed, and how will risks and benefits be allocated among the participants?

The agency or consortium initiating the program can retain direct responsibility for managing the system (e.g., clearinghouse functions), or it can involve the private sector through a contracting or partnership arrangement. The basic management strategies are as follows:

- Direct transit agency responsibility for management, with contracts for equipment and specific support functions
- Private contracting for overall operation
- Partnership with a private company, with responsibilities divided between the partners or formation of a new entity that is responsible for all functions

With regard to financing and business models, the following general approaches have been utilized:

- **The participating agencies form a consortium and jointly finance the implementation and operation of the system**; the integrator may also participate in the financing. This is the approach used in Hong Kong.
- **A single lead agency provides all or most of the funding for the new system** (again, possibly with assistance from a private partner). This will be the approach in Los Angeles in its forthcoming Unified Fare System, as the LACMTA will provide the funds to implement a common fare system for all of the regional transit operators. In San Francisco, the Metropolitan Transit Commission (the regional MPO) is providing the bulk of the funds (much of them from federal sources) for the TransLink program.
- **The system integrator finances the implementation** - i.e., as part of a design/build/operate/maintain (DBOM) contract. This is the approach in London, where the PRESTIGE team's payments are tied to meeting specified performance standards. The private consortium in London is actually managing London Transport's entire revenue collection operation.

In cases where a private entity provides financing and manages the system, the participating agencies typically pay a transaction fee for these services. The amount of the fee and its basis are clearly important elements in negotiating a contract with the private partner.

The following table summarizes the basic organization/ownership structure of a number of regional systems:

Initiative	Procurement	Private Sector Role	Source of Funds for Purchase	Ownership	Operations Responsibility
NYCT MetroCard ***Traditional "agency purchase"***	• Single agency	• Integrate	• Single agency	• Single agency	• Single agency
E-ZPass ***Independent systems, coordinated technology***	• Separate agencies • (using standard tag and reader)	• Different companies integrate and operate systems	• Separate agencies	• Separate agencies • (through Interagency Group)	• Integrators
San Francisco TransLink ***Joint agency effort, outsource clearinghouse***	• Joint • Led by Metropolitan Transportation Commission	• Integrate and provide clearinghouse services	• Clearinghouse: Integrator • Fare collection equipment: Agencies	• Clearinghouse: Integrator • Fare collection equipment: Agencies	• Clearinghouse: Integrator • Fare collection equipment: Agencies
Seattle RFCS ***Joint agency effort, outsource clearinghouse***	• Joint • Led by King County Metro	• Integrate and provide clearinghouse services	• Clearinghouse: Integrator • Fare collection equipment: Agencies	• Clearinghouse: Integrator • Fare collection equipment: Agencies	• Clearinghouse: Integrator • Fare collection equipment: Agencies
Washington (DC) SmarTrip ***Traditional "agency purchase"***	• Single agency (an integrated regional program is planned)	• Integrate	• Single agency	• Single agency	• Single agency
Los Angeles MetroCard ***Lead agency buys for all***	• Joint • Led by LACMTA	• *To be determined*	• LACMTA	• *To be determined*	• *To be determined*
Atlanta Visa Cash ***Agency as open system merchant***	• Joint by 3 banks • Led by Visa	• Integrate and provide central system • MARTA an open system merchant	• Banks and Visa	• Clearinghouse: Visa and Banks • Fare collection equipment: Banks	• Clearinghouse: Visa and Banks • Fare Collection Equipment: MARTA
Hong Kong Octopus ***Joint agency effort, self-operated***	• Agency consortium	• Integrate	• Agency consortium with integrator investment	• Clearinghouse: Consortium • Fare collection equipment: Agencies	• Contracted to MTR, one of the agencies
London PRESTIGE ***Private finance, complete outsourcing***	• Single agency	• Integrate and operate, including agency fare equipment operations	• Integrator	• Agency (integrator holds operating lease during contract period)	• Integrator

9 Action Plan for Regional Consensus

The suggested recommendations and action plan have been developed to address many of the current issues challenging regional decision-makers. The action plan details a sequence of implementation steps that will continue to facilitate the development and deployment of a coordinated, regional transportation payments system.

- The public view of transportation payments in the region, for transit, parking and toll roads, is that of a fragmented system. Customers need to be familiar with the diverse payment structures of each service provider as well as the various types of valid fare media and payment methods. This is a barrier in particular for transit use, since most commuters need to use services provided from multiple agencies to complete their trip. Visitors will often use Metrorail but find the prospect of a longer journey that would link with other services intimidating. There is a substantial opportunity to improve transit ridership and revenue for all agencies in the region. By simplifying the fare system, and developing a coordinated regional payment system infrastructure that utilizes smart card technology, the public perception will shift to viewing the various services as a seamless transit system that is easier to use and more appealing.
- Movement towards using various types of electronic payments system (EPS) technologies to simplify transportation payments in the region has already begun and public acceptance has been strong. About 50% of the daily toll payments on the Dulles Toll Road use a Smart Tag transponder and the WMATA SmarTrip system recently celebrated the issuance of the agency's 100,000th SmarTrip card. Many of the region's bus and commuter rail operators are considering or planning to adopt a smart card based payment system.
- To be successful, a regional smart card based payments system must be developed in a coordinated manner. Smart card equipment from multiple vendors is not always compatible. There is the risk that smart cards might not be accepted with all agencies. Regional decision-makers must commit to taking the necessary steps to ensure regional interoperability when planning their overall programs. Currently, the WMATA SmarTrip system uses proprietary technology only available from Cubic Transportation Systems. Other agencies may choose to purchase smart card equipment from a different vendor, and the path to achieving interoperability under these circumstances is likely to be time consuming and expensive. Establishing an agreement on a regional technology standard could help mitigate this scenario and could facilitate the development of a more "open" payment system supported by multiple vendors.
- Garnering early political support for the further development and deployment of a regional transportation payment system is critical. Transportation decision-makers must be able to clearly articulate a guiding vision and the implementation objectives of the program to the region's political officials. In turn, political officials need to work with key agency officials in establishing a suitable priority for facilitating inter-agency collaboration and establishing mechanisms for setting policy and key decision-making.
- Other sectors of the economy, such as banks and federal government agencies, are currently developing and deploying smart card programs of their own. Smart card technology enables multiple application systems that will make the cards more useful to

customers and allows costs to be shared. These potential non-transportation partners are interested in the added value that transportation partners can add to establishing a larger market penetration for their programs. In an effort to leverage this potential market share to the private sector, transportation agencies would benefit from developing a joint system that builds on the economies of scale in the region and would thus be more valuable for establishing a mutually beneficial regional system with other non-transportation partners.

9.1 Need for Consensus and Collaborative Regional Planning

A joint system for processing payments will have fundamental impacts on many areas of business, including revenue operations, customer service, marketing and maintenance. A consensus-building process, even if the final result falls short of complete agreement in all matters, is needed for the participants to understand the benefits of the approach and be willing to undertake the capital investments, organizational changes and political risks.

This study has developed initial candidates for a ten-year vision, migration path and initial deployment. It has also highlighted some of the critical challenges and issues that need to be addressed.

The first step will be for potential participants in the system to define an action plan for establishing a collaborative planning process. This process should pursue consensus, in a practical and timely way, on:

- Market research or other required investigations
- Regional longer-term vision
- Achieving interagency smart card interoperability
- Migration strategy
- Addressing deployment challenges and issues.

From the stakeholder interviews, there appears to be a general consensus among the transit agencies in the region that customer smart cards should be accepted by all agencies in the region, using a system building on the foundation and initial success of the current WMATA SmarTrip system. MWAA is also interested in participating.

Regional parking and toll collection agencies, although not ruling out their participation, have not decided whether to pursue a multimodal system that moves beyond the SmartAccess system to also accepting the smart cards that are accepted by the transit agencies. With TransPass, the main issue seems to be the need to resolve a variety of technical and business issues. With Smart Tag, the questions involve generating additional market research data about what benefits participation would offer.

With basic agreement on a longer-term vision and migration strategy, agencies can begin consistent deployments. The results of these early deployments will tend to provide useful insights that will assist with continuing efforts to refine the future migration path.

9.2 Recommended Implementation Strategy

There are two main areas that the implementation strategy must consider:

- Expanding smart card acceptance regionally on the foundation of the current WMATA system
- Linking the regional smart card system to the other regional electronic payment systems, such as Smart Tag and TransPass.

9.2.1 Regional Smart Card Acceptance

WMATA has completed the initial SmarTrip system for Metrorail and the park and ride lots using Cubic equipment. The initial step in expanding acceptance of the WMATA SmarTrip cards is already underway - buying new Metrobus fareboxes that will support SmarTrip. The new fareboxes will allow a single farecard to be used with Metrorail and Metrobus, although Metrobus will not necessarily use Cubic equipment. Different smart card readers would be needed to let the Cubic faregates read other types of cards, and this will require Cubic collaboration. In an analogous situation at BART in San Francisco (as is discussed further in section 5.2.2), interfacing Cubic faregates with smart card readers from another vendor is requiring the development of a specialized embedded control system by a third party vendor. This avoids the need for the competing AFC vendors to share intellectual property with each other.

An interoperability issue may develop if any other agencies procure incompatible smart card equipment from that eventually selected in the current WMATA/MTA fareboxes procurement.

All of the regional transit agencies should discuss methods at the earliest opportunity to foster interoperability between SmarTrip and other emerging transit payment systems in the region.

Some other transit agencies are expected to purchase SmarTrip-ready fareboxes through the WMATA procurement. Some will buy only SmarTrip readers, while others will buy readers integrated with validating fareboxes. These transit agencies may simply accept SmarTrip cards, or they may pursue introducing smart cards of their own and pursuing the acceptance of their smart cards by the other agencies in the region. Some non-transit agencies (such as MWAA parking) may also procure smart card equipment, integrate it with their systems and explore interoperability with SmarTrip.

The consensus-seeking process between WMATA and other regional agencies on developing expanded electronic payments acceptance, now underway through the Fare Technology Working Group, should address all key issues including:

- **Will the cards support all agency passes and tickets?** Local agencies could accept WMATA SmarTrip stored value for fare payment if they have the new farebox, and submit the transactions to the WMATA SmarTrip system for reimbursement. Local bus agencies would then likely find SmarTrip cards replacing some former cash fares. The cards could also replace paper transfers for connections with other SmarTrip accepting buses.

If the cards also support the equivalents of local agency passes and tickets, the local agencies could replace a larger portion of their fare payments. A local bus agency could also choose to adopt the "Fair Fares" policy being considered by WMATA, with all payments from stored value and a discounts program based on ride frequency to emulate the discounts available from passes. This would be an alternative to having their prepaid fare media emulated directly on the cards.

This will initially be primarily an issue about the planned acceptance of cards issued by WMATA at other agencies. In the future, the issue could also arise with the regional use of smart cards issued by other agencies.

Regional use of smart cards should support all the existing fare media of participating agencies. This coordinated approach will effectively promote smart card market penetration in the region. This approach does not necessarily mean that conventional forms of fare media must be eliminated, although this could be considered as a more extreme approach to enhancing smart card market penetration. However, there may be cost implications if all existing fare media continued to be accepted.

- **Revaluing arrangements for bus-only customers:** Many local bus customers do not use Metrorail stations. Additional revaluing at convenient locations, such as at local grocery stores, will be needed (WMATA faces a similar issue with expanding SmarTrip use to Metrobus). If the cards carry local agency passes or tickets, the revalue locations should include all the places where customers currently buy fare media.

  Agencies that support on-bus revaluing may collect more large-denomination bills. Local agencies currently deal mostly with $1 bills and generally don't have the bill sorting equipment used at WMATA. The overall success of the on-bus revaluing strategy remains to be proven in practice, since boarding delays associated with bill validation could emerge as a problem.

  Another complex matter with SmarTrip acceptance at other agencies will be the current WMATA revaluing bonus of 10% on revalues of $20 or more. If the bonus value can be used for fare payments with other agencies, WMATA may expect the cost of the bonus stored value to be treated as an operating cost of the clearinghouse (so it can be proportionally funded by the other agencies).

  Joint discussions should focus early on resolving some of the key issues associated with developing and supporting a regional revaluing infrastructure (the infrastructure that allow customers to periodically add value to their cards) for the multiple agency bus environment. A coordinated revaluing system will be critical to the success of smart card acceptance in the bus environment.

- **Who runs the clearinghouse and what are the business arrangements?** A centralized clearinghouse would typically be responsible for all "joint" functions in a multiple agency system. This could include issuing cards, operating the revaluing infrastructure, processing revaluing transactions, holding prepaid funds, processing fare transactions and making settlement payments to participating agencies. Agencies could jointly govern the clearinghouse operating rules, and may need to pay transaction fees to the clearinghouse to fund its operation. Issuing cards and operating the revaluing

infrastructure are often done by the agencies on behalf of the clearinghouse (and agencies may be paid a commission by the clearinghouse for providing this service).

Alternative approaches include:

- **WMATA independently controls a system that becomes the de-facto centralized regional clearinghouse when SmarTrip cards are accepted by other agencies:** The WMATA system would hold all the prepaid funds and receive the float proceeds. WMATA might also expect these local agencies to pay transaction fees for processing their fare transaction data. In general, local agencies may not want to rely for a portion of their fare collection revenue on a system entirely under WMATA control. One of the agency concerns would be responsibility for developing revaluing infrastructure in their service area.

  A WMATA regional smart card clearinghouse might not be available for use with non-SmarTrip cards that might be later introduced by other agencies. Some agencies might eventually decide they want to set up a parallel and interoperable system for regionally accepted smart cards. In this case the structure would evolve towards a decentralized clearinghouse that relies on a web of bilateral arrangements between clearinghouse systems, analogous to the arrangements between E-ZPass Customer Service Centers.

  All of the participating agencies should have a voice in developing the operating agreements and business structure that will provide the foundation for the regional clearinghouse operation. If an agency cannot participate in a shared clearinghouse that meets its needs, yet also cannot afford to set up their own clearinghouse to participate as part of a decentralized system, that agency might be deterred from participating in a regional program. The result could be an undesirable fragmentation of a regional program, where customers become confused about card acceptance, lose confidence in the card, and overall market penetration is impaired because some agencies do not accept certain smart cards.

- **Clearinghouse is operated jointly:** A joint clearinghouse would allocate revenues and costs based on the transaction data (a joint clearinghouse arrangement could involve any of the various alternative arrangements discussed in section 5.3, including the centralized, decentralized and open system linkage approaches). Revenue for agency-specific passes could be allocated to that agency right away, while revenue for joint passes and stored value could be allocated based on fare transactions. Agencies could contribute towards clearinghouse operating costs based on their share of the overall transactions processing load. The most important aspect of joint operation is that it be jointly governed.

  The joint planning process for the regional expansion of smart card acceptance needs to focus on developing operating procedures that define an equitable allocation of costs and revenue sharing among all participants.

- **How would the joint system expansion be financed?** There are several alternatives for funding the capital costs of a joint clearinghouse. Early identification of a source of funds that would cover the bulk of the system should accelerate both developing the

consensus and the timetable for implementation by all agencies. The funds could come from one or more of the participating agencies or from some external source (e.g., a private sector partner) – or perhaps a combination of public and private funding. The clearinghouse system capital costs could conceivably be entirely funded by the private sector, as in the San Francisco TransLink system (in this approach, the agencies do not own the clearinghouse and the avoided capital costs are shifted into higher operating costs in the form of transaction fees).

Dulles Corridor Rapid Transit should continue to be engaged in the joint planning process for expanded regional smart card acceptance. All of these services will link with Metrorail and will provide an excellent opportunity to emphasize in a high profile setting how regional smart card acceptance can enhance multimodal operations.

9.2.2 Linking Regional Systems

Other electronic payment systems in the region that are not part of initial regional smart card acceptance could eventually accept the smart cards issued by transit agencies. Examples of such other systems that are currently in place or being developed are TransPass and Smart Tag. Like other participants in regional smart card acceptance, agencies would submit their smart card payment transactions to the clearinghouse for reimbursement.

However, there are technical, institutional and business issues to be resolved before smart card acceptance would be likely beyond transit.

Market research and business case assessments should be undertaken that focus on estimating whether there could be measurable benefits to toll and parking agencies from accepting the smart cards used with regional transit agencies. Benefits could include an increased revenue stream or reduced operating costs. Interest in participation based upon the business issues could provide the motivation for the public and private sector participants to resolve the institutional and technical issues.

The SmartAccess proposal involves a form of specialized joint clearinghouse that does not require that acceptance of regional transit smart cards by non-transit agencies. The SmartAccess system would be limited to establishing a joint account for customer automatic revaluing. If a person uses more than one of the payment systems, a SmartAccess account would let them avoid needing separate automatic account revaluing arrangements with each system.

Implementation of the SmartAccess program should proceed. As a supplementary system, SmartAccess will enhance the attractiveness of each of the region's electronic payment systems to customers. For customers that use more than one of these payment systems, SmartAccess will help demonstrate that these systems are operating in an integrated manner. The customers who use SmartAccess will tend to be those who use more than one of the many regional electronic payments systems. SmartAccess can also provide useful market research data about the potential demand for smart cards that can be used with all these systems.

If the smart cards issued by transit agencies are eventually accepted in non-transit electronic payment systems, the continuing need for a SmartAccess system that is distinct from the

transit clearinghouse will depend on whether the non-transit systems continue to support other electronic payment methods in parallel with smart card acceptance:

- The contact TransPass smart card could be entirely replaced by the smart cards issued by transit agencies. This is a plausible scenario if transit smart cards become very successful in DC and if the institutional and technical issues can be addressed. In this case, DC DPW would likely be participating in the smart cards clearinghouse in a quite similar manner to any of the other agencies involved. There would no longer be a TransPass account separate from the transit account and the SmartAccess system would not be needed.
- The Northern Virginia toll operators could decide to require use of a smart card for all Smart Tag transactions. This does not seems a likely scenario since smart card accepting transponders will be more expensive and require the extra customer actions of inserting and removing the card from the transponder. It is more likely that conventional transponders would be retained, with smart card accepting transponders available as an option for customers who have other uses for the card and want to do all their payments through one system.

  Also, Smart Tag supports toll agencies throughout the state. Agencies outside Northern Virginia, where SmarTrip will not likely be in use, will not want to use smart card accepting transponders. It seems that the Smart Tag system will continue to operate a parallel system of accounts linked to transponders, regardless of whether transponders that accept smart cards are eventually introduced. In fact, a Northern Virginia Smart Tag customer who prefers using a smart card accepting transponder would still need to maintain a transponder-linked account with some balance if there are occasional trips to Richmond Smart Tag systems.

Even if TransPass and the Northern Virginia toll agencies eventually accept smart cards directly, a SmartAccess system separate from the expanded clearinghouse will continue to be useful, to support automatic account revaluing with transponder accounts that may choose not to adopt the smart card approach. Transit, parking and toll agencies in the region should work together to structure the regional transit smart card acceptance system, TransPass, Smart Tag and SmartAccess as interrelated and mutually supportive parts of an overall regional electronic payments systems infrastructure.

9.3 Recommendations for Implementation :

The following implementation steps should be initiated, in the general time sequence indicated, to move towards a regional payments system and build on the progress of the Fare Technology Working Group:

- **Hold Stakeholder Workshop:** A workshop should be convened to brief stakeholders on the findings of this study, as well as the experiences of regional integration efforts, such as those in San Francisco, Seattle and overseas (e.g., Hong Kong, Paris, London).
- **Begin to Identify / Establish Funding Requirements and Mechanisms:** Develop high-level cost estimates for building the common vision. Review the funding

mechanisms available to the agencies involved and determine which have the potential to support this system.

- **Explore Third Party Partnerships:** Conduct initial discussions with potential private or other public sector partners to explore opportunities to enhance cardholder convenience or reduce costs by synchronizing the visions. The Smart Card Forum is one potential vehicle to facilitate this (for example, Smart Card Forum hosted a dedicated session on smart cards in transportation in June 2000).
- **Seek Political Support:** Work with the offices of local elected officials (in the District, Maryland and Virginia), state legislatures, the two governors and the federal government to establish the support needed by each agency to facilitate a priority effort in this multi-agency project. It will be important to help these officials understand the potential political benefits in establishing themselves as early champions for a system that will significantly increase the convenience of transit for seamless regional travel. The intent would be to achieve political buy-in on the general concept early in the effort and direction for technical staff to develop a detailed implementation plan. It will also be important for the political supporters of the project to be assured that they will be the ones making the policy decisions at critical stages of the effort. This would include assurances that the final decisions on choosing between significant alternatives and whether to proceed with implementation will rest with them.
- **Establish or Designate a Regional Collaborative Organization:** A formal organization for this joint effort will need to be established or an existing organization designated for this purpose. Fundamentals that will allow the members to make progress include:
  - An executive committee to set policies and specific objectives.
  - One or more technical committees to develop details of joint operations and technology standards.
  - A mechanism for pooling funding.
  - Access to additional technical expertise and resources when needed.
- **Establish a Common Vision:** Agree on the general concept of operations, features and participants desired and achievable for the region in the medium to long term.
- **Identify Deployment Issues:** Building on the results of this study, determine specific categories of deployment issues and challenges for which collaborative decisions will be required. This will include all shared services of the system, including: costs and revenue sharing, branding, clearing and settlement rules, marketing, customer service, revaluing networks, third party relationships, etc.
- **Plan Initial Deployment(s):** Select one or more initial deployments that will provide practical experience with implementing the technology beyond the single agency environment.
- **Develop Regional Operating Agreements and Business Structure:** Operating agreements should be developed that identify and define shared services in the system.

Shared services could include how clearing and settlement will be operated and how revenues and costs will be shared. The business structure for the expanded clearinghouse will also have to be identified. For example, it could be jointly managed by all the agencies through a consortium or managed by a third party such as the systems integrator.

- **Establish Regional Interoperability Mechanisms:** The group should jointly develop interoperability mechanisms that would allow any agency's smart cards to be accepted at any of the agencies in the system. This effort should be able to benefit from the experience of the TransLink Program in the San Francisco Bay Area, as well as from initiatives to develop multi-application card standards in Europe. Interoperability decisions will obviously be strongly influenced by the choices made by WMATA in the current farebox procurement, as well as by the eventual technology decisions made by other agencies in the region.
- **Define the Migration Path and Implementation Program:** The migration path needs to identify the sequencing of specific implementation efforts. A complete implementation program can then be developed, establishing the specifics such as the scope and timing of each project, programming the funding and determining the most appropriate procurement mechanisms.
- **Expand Private Partnership Outreach:** As the system becomes real, efforts to seek out third party partnerships should be intensified. At this point having developed comprehensive details for a joint regional transportation payments effort will prove valuable, as it will enable the participating agencies to negotiate effectively and as a significant group with potential multiple application card program partners.

To ensure progress on these issues, each participating agency must commit staff resources with the appropriate expertise. In addition, the agencies should consider supplementing their staff with consulting services of experts in electronic payments systems, and should coordinate with related initiatives promoting electronic payment systems in transit, including those of the Federal Transit Administration, ITS America and the American Public Transit Association and others.

The development and implementation of a regional payments system is a complex undertaking and can be expected to take significantly longer than the procurement and installation of the initial single agency Smart Tag or SmarTrip systems. In the San Francisco and Seattle areas, for instance, the regional consensus development processes have each been underway for several years. Each region undertook extensive research efforts, comparing different payment technologies and determining the full range of system integration and clearinghouse details. Results from the pioneering efforts at these agencies can be leveraged to streamline the timelines for the Washington region. However, it will nonetheless likely take several years to complete the overall effort. s and Dulles Corridor efforts).

Regional Initiative	Began Formal Consensus Process	Began Procurement	Plan to Begin Deployment	Plan to Complete Deployment
San Francisco	1995	1997	2000	2003
Seattle	1994	1998	2001	2003

10 Summary

Development of an integrated regional payment infrastructure for the Washington area will be a complex undertaking. Nevertheless, the benefits of creating a seamless transportation system, the initial success of Smart Tag and SmarTrip and the burgeoning role of electronic payment technologies in both the transportation arena and many other settings, make this the right time to build on what has already been accomplished. Similar smart card-based systems are being established in major metropolitan areas around the world; several are in place already, while others are under development or in the testing phase. The transit, toll and parking agencies in this region can take advantage of the lessons learned from these programs and the continued refinement of the technologies. A state of the art system can both attract new customers and improve the transportation experience of current customers.

The agencies should:

- Continue the current SmarTrip expansion and SmartAccess efforts
- Establish a regional consortium now. Develop a common vision and implementation strategy, define the interagency interoperability mechanisms and include smart card provisions in all appropriate fare collection procurements.
- Ensure electronic payment systems are incorporated into Dulles Corridor Rapid Transit in a way that is integrated with the overall regional effort.

APPENDIX A: Glossary

Auto-Replenishment	A system that allows customers to have their prepaid account balance increased automatically from their credit card, by a set amount and triggered whenever the balance drops below a set threshold.
ART	Arlington Transit – The local bus agency in Arlington County
Bluetooth	A short-range wireless radio frequency communications technology standard recently developed by major manufacturers, for which commercial products are currently emerging
Clearing	The reconciliation of accounts prior to settlement in a clearinghouse system.
Closed System	A payment card transaction processing system where the system owner selects the card issuers and acceptors (i.e. most transit fare collection systems)
CSC	Customer Service Centers - Central computer systems for electronic toll collection systems, operated for individual toll agencies
Cubic	Cubic Transportation Systems – A major vendor of transit fare collection equipment and integrator of smart card based fare collection systems; integrator of the original WMATA SmarTrip system
CUE	The local bus service in the City of Fairfax
DASH	The local bus service in the City of Alexandria
DC DPW	DC Department of Public Works – Responsible for the administration of public parking facilities
DSRC	Dedicated Short Range Communications – A range of similar technologies used for short range radio frequency wireless communications between roadside equipment and vehicle mounted transponders; used in most electronic toll collection systems
ERG	ERG Transit Systems – A major vendor of transit fare collection equipment and integrator of smart card based fare collection systems; participates in a marketing alliance with Motorola
ETC	Electronic Toll Collection – systems that use vehicle transponders to automate the process of accumulating highway toll transactions
E-ZPass	The service mark for ETC systems operated by numerous toll agencies in the United States northeast; interoperability mechanisms have been established to allow a transponder issued by any E-ZPass system to be used with any other E-ZPass system to make payments from the home system account
Fairfax Connector	The local bus service in Fairfax County
FCC	Federal Communications Commission – Regulates the allocation and usage of radio frequency spectrum

FTA	Federal Transit Administration
IAG	Inter Agency Group – E-ZPass toll agencies collectively comprise this organization, which manages the interoperability aspects of the overall system
ISO 14443	The ISO international standards body have published some portions of this standard for short range contactless interface smart card technology
ITS	Intelligent Transportation Systems – Overall term for the use of a range of advanced technologies in enhancing the operation of transportation systems
Lockheed Martin IMS	A major transportation systems integrator and operator; responsible for the TransPass and M-Tag systems
Loudoun County Commuter Service	Commuter bus service connecting Loudoun County with Washington DC.
Magnetic Stripe Card	Plastic or paper tickets or cards carrying data stored on a stripe of magnetic material; used in credit cards, debit cards and many fare collection systems
MARC	Commuter rail operations administered by the Maryland Mass Transit Administration
Mark IV	A major vendor of electronic toll collection DSRC equipment; sole vendor for equipment used in the E-ZPass and Smart Tag systems
Metro Access	WMATA paratransit service
Metrobus	Bus operations of WMATA
MetroCard	Advanced fare collection system for the New York City Transit Authority, based on stored value magnetic stripe cards
Metrorail	Rail operations of WMATA
Mondex	A stored value open system, owned by Mastercard and franchised to various financial institutions
Motorola	Motorola Smart Card Solutions division – Part of the worldwide electronics giant, a major vendor of transit fare collection equipment and integrator of smart card based fare collection systems; participates in a marketing alliance with ERG
MTA	Maryland Mass Transit Administration – Transit agency coordination body for Maryland and the transit agency for the Baltimore region (also responsible for administering MARC and other intercity commuter services as well as the M-Tag toll collection system); can also refer to the New York City region Metropolitan Transportation Authority, which is responsible for most transit service in New York state portions of that region

M-Tag	Electronic toll collection systems for highway toll facilities in the Baltimore region
MWCOG	Metropolitan Washington Council of Governments –The primary intergovernmental coordination body for the DC region
NVTC	Northern Virginia Transportation Commission – A transit coordination body in Northern Virginia; co-owner with PRTC of VRE
Open System	A payment card transaction processing system where participation as a card issuer or acceptor is not restricted but does require adherence to the system operating rules (i.e. credit and debit card systems)
PIN	Personal Identification Number
PRTC	Potomac and Rappahannock Transportation Commission – A transit agency coordination body and bus agency for a region in Northern Virginia; co-owner with NVTC of VRE
Reader	Devices that communicate with customer payment devices such as transponders and smart cards
Revaluing	The process of making a customer making a prepayment and having the corresponding stored value added to their card.
Ride On	Local bus service for Montgomery County
Settlement	The process of transferring funds to outside claimants, after completion of the clearing process, in a clearinghouse.
Smart Card	A plastic card with an embedded computer chip and the means to communicate with a reader, often as part of a customer payment system; communications methods include contact (requiring insertion into a reader slot), contactless (requiring only that the card be brought within close range of the reader) and hybrid or dual interface systems that combine both methods.
Smart Tag	ETC system supporting highway toll facilities administered by VDOT
SmartAccess	A consortium of transportation agencies in the DC region that are considering measures to enhance payment systems integration between the Smart Tag, SmarTrip and TransPass systems
SmarTrip	The WMATA contactless smart card based fare payment system
Stored Value Purse	The balance for a prepaid account is stored on a smart card or magnetic stripe card so that readers can check it without needing to communicate with a central computer system; readers accumulate transactions that are periodically transmitted to update the central system
The BUS	Local bus service for Prince George's County

TPB	Transportation Planning Board of the National Capital Area – A separate board of MWCOG, the DC area Metropolitan Planning Organization and responsible for coordination between the transportation plans of various regional agencies
TransPass	A smart card based parking payment system being planned by DC DPW and Lockheed Martin IMS.
Transponder	The vehicle mounted DSRC device that identifies the payment account in ETC systems
TVM	Ticket Vending Machine – An electro-mechanical device for the self-service purchase and/or validation of fare media
VDOT	Virginia Department of Transportation
VDRPT	Virginia Department of Rail and Public Transportation
Visa Cash	A stored value open system, available for use by Visa member financial institutions
VRE	Virginia Railway Express – Administers commuter rail operations in Northern Virginia
WMATA	Washington Metropolitan Area Transit Authority – DC regional transit operator

APPENDIX B: References

Title	Author	Date
Developing a Regional Approach to Fare Collection	Booz Allen & Hamilton (for WMATA)	2000/05
Technology and Information Management Program – Strategic Plan	Virginia DOT	1999/10
SmartAccess: Proposal for Electronic Payment System for Transit Fare Collection, Parking Payment, Electronic Toll Collection and Other Applications	WMATA (in collaboration with the SmartAccess consortium)	1999/10
Regional Fare Integration	Booz Allen & Hamilton (for WMATA)	1998/12
Northern Virginia Annual Transportation Update	Northern Virginia Transportation Commission	1998/10
Smart Card Driver's License Feasibility Study	CSC/PB Farradyne (for Maryland DOT)	1997/12
1999 WMATA Service Area Usage and Attitude Assessment Research	QS&A Research & Strategy (for WMATA)	1999/07
Metrobus Customer Satisfaction Survey	QS&A Research & Strategy (for WMATA)	1999/02
Regional Bus Fare Collection System: Request for Proposals FJ5872	WMATA and Maryland Mass Transit Administration	2000/01
Automatic Fare Collection System: Request for Proposals #00-005	Virginia Railway Express	2000/02
Dulles Corridor Rapid Transit Project Technology Implementation Plan	PB Farradyne (for the Dulles Corridor Task Force)	1999/12

APPENDIX C: Interviews

Organization	Interviewed	Date
Alexandria DASH	Sandy Modell, Eric Randall	2000/03
Arlington County Treasurer's Office (Parking)	Paul Forte, Frank O'Leary	2000/01
Arlington Transit	Eric Smith	2000/01
Diamond Transportation Services	Jacob Mayhew, Robbie Werth	2000/02
Dulles Greenway	Mark Manlove	2000/02
Fairfax Connector	Andy Szokas	2000/02
Lockheed Martin IMS	Duke Hanson, Matt Silverman	2000/04
MARC	Kathy Waters	2000/02
Maryland MTA	Jim O'Donnell, Simon Taylor	2000/02
Metropolitan Washington Airports Authority	Mike Hackett	2000/01
Montgomery County Ride On	Carolyn Biggins, Bill Selby	2000/02
MWCOG	Andrew Meese	2000/01
Northern Virginia Transportation Commission	Sharmila Samarasingh, Rick Taube	1999/11
Virginia DOT (Data Management Division)	Murali Rao	2000/02
Virginia DOT (Fiscal Division)	Miriam Daughtry	2000/02
Virginia DOT (ITS Division)	J. R. Robinson	2000/02
Virginia DOT (Northern Virginia District)	Fatehmeh Allehdoust, Rahul Travedi, Ken Wester	2000/02
Virginia DOT (Smart Tag)	Bill Costis, John Jusevich, Liliane Ramadan	2000/02
Virginia DRPT	Corey Hill	2000/01
Virginia Railway Express	Howard Shock	2000/02
Washington Parking Association	Phil Carr	2000/01
WMATA	Greg Garbeck	2000/01
WMATA (Park and Ride)	Ron Habegger	2000/01