APPENDIX A. TRANSIT APPLICATIONS OF EMERGING FARE DEVELOPMENTS

REGIONAL INTEGRATION

CONTACTLESS SMART CARD APPLICATIONS

CONTACT CARD APPLICATIONS

REGIONAL INTEGRATION

San Diego Region Fare Integration

The Metropolitan Transit Development Board (MTDB) came into existence on January 1, 1976 and five years later started the San Diego Trolley with the original 16 mile South Line. It was the first property in the USA to implement the Proof of Payment (POP) system. It has ticket vending machines and validators at Trolley stops. Bus fare collection is operator monitored.

The MTDB serves as the policy setting and overall coordinating agency for public transportation in the San Diego metropolitan area. The fixed-route operating entities have banded together to form a "federation" of transit service providers called the Metropolitan Transit System (MTS). The average daily ridership (FY91) was 164,000 with an overall farebox recovery ratio of 49%. There are six regional operators who provide contract service and two MTDB subsidiaries - San Diego Trolley and San Diego Transit. The purpose of MTS, and the related MTS symbol, is to identify this unified transit system to the public. In FY 1993, the MTS system carried over 61 million riders on 68 routes and 24 million service miles. The service area is 570 square miles with a population of about 1.9 million people. MTDB's overall responsibilities include allocation of subsidy funds, preparing the Short Range Transit Plan for its area of jurisdiction, development of light rail and bus service coordination and overseeing all services provided by the MTS.

Responsibilities within the fare and revenue system have been divided up as follows:

The San Diego Association of Government (SANDAG)

- Ensures that each operator submits Ready Pass boarding and 10-Pack Ticket counts.
- Determines the proportion of revenues to be allocated to each operator and prepares appropriate reports.

MTDB

- Funds and administers the design and purchase of fare media.
- Manages the prepaid fare program including distribution, and sells Ready Passes, Day Tripper and 10-Pack Tickets, Trolley Multi-ride Tickets and all other group sales tickets and submits sales summary to each operator.
- Determines the proportion of local sales tax subsidy to be allocated to each operator for senior/disabled and youth passes.
- Keeps a separate fund for all pass and ticket sales revenue.

Operators

- Keep pass use and ticket counts.
- Provide monthly summary to SANDAG.

Four service types are classified. They are:

- Express/Premium Express/Commuter Express
- Urban
- Local/Feeder
- Demand Responsive

The fare structure includes cash fares, with differences by mode and by distance on the trolley service, as well as other fare media including 10-Pack Tickets, which are 10 individual tickets (thin enough to be inserted in the farebox and stiff enough to be validated for the Trolley ride), Trolley Multi-Ride Tickets (which allow multiple rides on one ticket but cannot be used to start a journey on the bus), and two types of tokens (valid on San Diego Transit services only). Transfer and upgrade charges also apply when transferring to a higher level of service.

MTDB, as the state regional transportation coordinating agency, took the lead in establishing fare integration and developed the Uniform Fare Structure Agreement. It applies to fixed route operators only, although dial-a-ride operators participate in the agreement. The Uniform Fare Structure Agreement:

- Establishes a uniform fare structure for the region providing a coordinated public transit system to the public in a multi-operator environment.

- Establishes a regional transit pass valid for travel on all fixed-route service in the San Diego region, including a formula for distribution of pass revenue.

- Establishes a regional policy of free transfers between equal or lower levels of service and sets transfer fares to higher levels of service, protecting coordination of transfers between operators.

This agreement is updated annually. Regional Monthly Passes and Regional 10-Pack Tickets are accepted by all operators participating in the agreement. The base pass revenue is allocated to each operator, based on the operator's percentage of regional pass boardings for all adult passes. Slightly different arrangements are used for the higher priced passes, although the allocation is based on the number of riders and transfers on each system. Establishment of MTS and the use of Ready Passes and 10-Pack Tickets has given passengers a common identity and a common fare medium, even with an array of different service levels and vehicle types.

San Francisco Bay Area - TransLink Project

TransLink was the first on-board automated joint transit fare collection (regional fare integration) program in the United States. It was designed to allow transit passengers to use a single ticket for both bus and rail. In its initial phase, the ticket was used on BART, 112 Central Contra Costa Transit Authority (CCCTA) buses and 45 BART Express buses. The program was developed under the sponsorship of the Metropolitan Transportation Commission (MTC), the regional transportation planning organization for the nine county San Francisco Bay Area.

TransLink was developed to improve transit access and passenger convenience in the region, as the tickets were intended to provide a seamless method of fare payment for passengers using more than one transit property. MTC first proposed the idea of a universal ticket in 1978 as a way to improve transit access and use among the 26 public transit operators in the MTC region. MTC began by working with the transit operators to develop interim multi-modal passes and tickets valid on two or more transit systems. The system initially used magnetic stripe stored value tickets so that each property and transit mode within a property may retain its own fare structure and collect its appropriate fare, but with one ticket. Each ticket had a unique serial number so that counterfeiting could be controlled and individual trips could eventually be tracked.

Bus Ticket Validators (BTVs) were produced by CGA of France, and were tested in revenue service on CCCTA and BART Express Buses. The BART fare gates were modified to accept TransLink stored value tickets; thus, TransLink tickets were accepted as transfers from buses and credit was given for having paid the bus fare — and, in turn, anyone transferring from BART to a bus receives credit for having just completed a trip on BART. Bus-to-bus transfers were similarly handled, whether it be between two buses in a property or two buses in different properties.

Components of TransLink

Tickets, validators, and vending machines are the principal components of the TransLink program. Each is described below.

- Tickets - The initial TransLink system was built around a magnetic stored value card similar to the ticket BART currently uses, although MTC and the individual operators have now decided that contactless smart card technology is more appropriate. The original TransLink tickets were sold in two denominations: $30 and $75 (valid for fares up to $80.) In addition, there were several built-in discounts over the regular BART and bus fares when a TransLink ticket is used for BART-to-bus and bus-to-BART transfer. There was also a last-ride bonus; one final ride can be made on BART or a bus with a remaining value less than the fare due. There was no time limit for using the stored values.

- Validators and Fare Gates - On buses, a TransLink ticket was inserted into the Bus Ticket Validator (BTV), which deducted the fare from the ticket and then printed the remaining value on the ticket. The ticket was used in the BART fare gate in the same manner. The BTV was designed for diversified fare schemes, automatic checking of transfers, and computer-generated statistics, so that the agencies could evaluate the system easily. In addition, equipment could be programmed to account for numerous variables such as peak/off-peak differentials, special days, or fare revisions. The equipment stored all transactions in a memory module, which was removable for downloading into a main computer.

Future Plans

A decision has now been made to expand the TransLink project throughout the region. However, MTC and the operators (including BART) have revisited the program's needs and have decided that the existing BART-type magnetic stripe ticket technology is not the most appropriate medium for the TransLink card. A comprehensive study was undertaken (completed in December 1995), evaluating technology and clearinghouse options, including the potential for private sector involvement. This study has led to a recommendation for a regional integrated system based on contactless smart cards; it has also been recommended that private entities be invited to participate in a range of system management and operational elements, particularly related to clearinghouse and equipment maintenance functions. A trial is planned for early-1997, with full regional implementation by end of 1998.

Significant Events in the Project

1985	Fare collection system consultant design contract issued.
1986	System design completed.
1987	Equipment specification completed. Proposals requested.
1988	Proposals evaluated and contract negotiated.
1990	Design Reviews performed.
8/91	BART compatibility testing completed.
11/91	First Article Test completed.
1993	In-service testing completed.
1994	Reliability, maintainability, and accuracy testing completed.
1995	Comprehensive technology and clearinghouse study undertaken.

Los Angeles Metrocard Project

The Los Angeles Metrocard Project was a demonstration project designed to show how a universal card can be implemented in the Los Angeles area. Since April 1994, three agencies, Culver City Municipal Bus Lines, Foothill Transit, and Montebello Bus Lines, have been equipped with validators, and the equipment has gone through reliability testing. GFI/Genfare produced the stand-alone bus validators and provided the computers and software for the program.

The Metrocard provides a common stored value fare medium which will permit bus and rail trip fare payment and transfer charges to be collected on buses, and in rail stations, by the property providing the service. The magnetically-encoded Metrocards are the size of a credit card. A predetermined value is deducted for each trip segment, with fare credit given for continuing trips on connecting buses and services. It is also hoped that the card will eventually be used for payment of parking charges. Metrocards are sold in pre-encoded values of $30, $20 and $10. The validator prints only when the remaining value is $10 or less, at which time a gauge mark is printed inside a designated boxed print area. As value remaining decreases, the box darkens to indicate the approximate value remaining. The validator on the bus visually indicates the exact value on the card.

The Metrocard was conceived after Los Angeles County Transportation Commission staff witnessed the progress being made in the Bay Area with its TransLink program. The Metrocard project was undertaken for the following reasons:

- Provide an inter-property fare media — The program was designed to test a system in which one instrument would permit a passenger to ride on all modes of public transportation, and each carrier would be reimbursed for services rendered.

- Reduce cash transactions — Extensive use of the Metrocard is expected to reduce the amount of cash on the buses and in the rail ticket vending machines. The cost of handling, processing, and securing this cash is significant.

- Eliminate paper transfers — Theft of bus paper transfer pads is a security concern and fare evasion is a problem for operators. Removing the pads from the buses removes a negotiable commodity from the street.

- Passenger convenience — The Metrocard provides a "seamless" system for a passenger who uses different agencies for transportation.

- Revenue enhancement — Fares will be collected in advance and use of the pass system can be tracked, enabling more accurate pricing decisions to be made.

Operation

The bus ticket validator deducts the appropriate fare based on the existing fare structure and records the type of trip being taken. The recorded data is extracted opto-electronically at each garage, and garage level reports are produced. Later in the program a clearinghouse may be added where sales of Metrocards, and revenue amounts due for each property, will be compiled for payment and individual travel records will be accumulated. Thus each property would be reimbursed for the service provided and the use of each card will be tracked, giving improved ridership data and allowing special targeted promotional activities.

There are several types of equipment for buses, Metro (subway and light rail lines) and Metrolink (commuter rail) operations under consideration which may eventually accept a common Metrocard for payment of a fare.

- Tickets : Metrocard is credit card size made of plastic material, with thermal coating on one side to accept printing. It can be reloaded with value up to 10 times.
- Buses : Validator and Operator Control Unit installed on each bus; garage microprocessor system; agency computer system
- Rail : Metrocard AVM to be installed at rail stations for the sale of tickets; AVM's procured for Metrolink have provisions for adding acceptance of Metrocards and existing Blue, Red and Green Line AVM's may be modified to accept the Metrocard; agency computer system
- Systemwide : Personal encoding machines to encode Metrocards of different values for sale at the agencies and other outlets; Metrocard vending machines which will vend Metrocards by accepting payment with currency or credit/debit (bank) cards; central computer system to serve as a clearinghouse for the Metrocard system

Significant Events in the Program

11/90	Consulting contract awarded
2/92	Equipment contract awarded to GFI-Genfare for bus validator equipment
11/92	First on-board installation demonstrated to LACTC and RTD Board Members
3/93	Shock and vibration, environmental and functional testing. Name "Metrocard" officially adopted
4/93	Driver training and marketing program began at Culver City
5/93	100 riders enlisted to use Metrocards. Metrocard introduced at Culver City bus.
3/94	Installed Validators on Montebello and Foothill Transit buses
6/95	Reliability and Maintainability Test (RAMT) completed

Future Plans

The official test period for the equipment and cards at the three properties ended in June 1995. The equipment has apparently been quite reliable and the test has shown that the concept is acceptable to both riders and operators. The properties planned to begin actively marketing the Metrocard for general use following the end of the test period. With the initial demonstration of the concept now complete, LACMTA has been evaluating its own fare collection situation, including whether to introduce the TPU's and Metrocard on its own services; budgetary constraints have delayed this decision at this point, as the property feels that it will need new fareboxes as well as any new ticket units.

Adelaide (Australia) Electronic Ticketing Project

The first electronic ticketing system in Australia was introduced into a regional proof of payment (POP) system operated by the State Transportation Authority of Adelaide (STA) in 1987. The system, provided by Crouzet (now Monetel) uses the Edmonson size - 30mm x 60mm - magnetically encoded ticket for up to 64 different ticket types. STA serves a population of over 1 million with 700 buses, 21 trams, and 145 rail cars.

Equipment includes validators and booking office machines for sales from outlets. The validator prints and encodes the trip data required for presentation to the inspector. Data transfer is done at the bus level by the driver who turns in his data module at the end of his tour of duty. The data is downloaded to a PC based system. Floppy disks are read at a central computer by the "sneaker net" method.

An unusual (to the US) feature is the sale of tickets by Bus Queue Sellers, who are "stationed" at heavy traffic points and sell tickets on the street. They carry a portable validator which encodes the cash ticket sales. The seller collects cash from passengers and makes change, takes a preprinted (not encoded) ticket from his/her signed out allotment, and validates the ticket for each passenger. The passenger is required to insert the ticket in the bus validator for POP-related visual printing and magnetic cancellation. Portable ticket readers are provided to the inspectors.

CONTACTLESS SMART CARD APPLICATIONS

London Bus Electronic Smartcard Ticketing Project

A feasibility study for use of Stored Value Ticketing (SVT) for London's buses was completed in May 1992, and concluded that such a system is clearly feasible and likely to be worthwhile. Further, the use of contactless smart cards would allow considerable flexibility of ticketing options, reduce ticket fraud, and could be expanded to include the full range of London Transport's current passes.

The trial has been conducted in two phases, starting with the 212 Demonstration Project and followed by a more extensive trial in Harrow. The aims of the trials are to:

- Assess the reliability and robustness of the available systems in day to day bus operations.
- Demonstrate the ability of the technology to control and monitor the use of unlimited travel passes.
- Test market a range of stored value ticket types to assess their marketability and to iron out operational problems.
- Provide experience from which a London-wide system could be evaluated and specified.

Contactless technology with no moving parts and no slots in which to poke foreign objects was selected since it was viewed as being more likely to survive the bouncing from the London streets, and would also limit the opportunities for vandalism.

The 212 Demonstration was conducted between September and December 1992 on Route 212 (between Walthamstow and Chingford in East London.) Existing pass and permit holders were given "212 Smartcards", in addition to existing passes, to use whenever they traveled on Route 212. Students at one school along the route were offered "Trip Cards", with 20 trips encoded on each. The equipment proved to be reliable and received a favorable response from the users.

The Harrow Trial was more substantial, and lasted for 18 months. It began in February 1994 with over 200 buses operating out of 7 garages for 5 operators, with a total of 19 routes. The system used GEC's contactless smart cards and AES Prodata equipment (as in Manchester) on about 150 buses. Westinghouse-Cubic's (WCL) equipment was also tested, by staff only, on 50 buses using their battery-powered contactless card. WCL's readers are required to process either type of card.

London Transport tested the two technologies and the use of period passes and stored value. Two different uses of the smart cards were tested:

- Smart Photocards - The passenger's photograph is imaged on the card at the point of issue (at the Harrow bus terminal and local newsagents). These act as prepaid passes or concessionary permits.

- Farecards - These will be introduced later in the year for an initial value of £10 (£12 worth of travel is given for a £10 payment). The farecards will be reusable.

The chief benefits of the scheme were expected to result from a reduction in fraud, improved ridership data, and faster boarding and alighting times. The new contract operations require detailed allocation of revenue among operators. Presently, this relies on detailed and costly surveying. The new system was designed to provide continuous complete data streams and remove the need for the comprehensive surveys. The improved boarding and alighting times may also allow a reduction in staff requirements, by eliminating two person operation on some of the more heavily used bus routes.

London Underground Touch and Pass Contactless Card Project

London Underground saw the contactless card as a means to increase rider throughput at the gates, while also facilitating entry for the handicapped and for travelers with luggage. Trial usage of the Western-Cubic Go-Card card was conducted between 1990 and 1991. Results of the first trial (from April to July 1990 using 458 contactless cards) showed a total of 190,000 passes using the Touch and Pass System during the trial. The reported results included:

- 52 cards failed. Of these, 49 were shown to have had the data reset to zero. Of the remaining three corrupted cards, one had been physically damaged and the other two had been incorrectly encoded.

- Riders reported that the speed of passage was very good; however, the number of passengers using the cards was less than 1 percent of the traveling population and thus did not constitute a sufficiently large sample for any significant effect on the overall flow rate.

- Separate control tests did show an average flow rate improvement of 17 percent when ticket holders were compared with contactless cardholders.

- Based on a passenger survey, riders rated the Touch and Pass system very favorably in terms of ease and speed of operation and failure rate in comparison with the existing magnetic ticket technology. As the cards were approximately 1/2 inch thick, although credit card size, only 24% rated the size of the card as very good, and 17% rated it as good, while 38% rated the size as acceptable, and 21% rated it as poor or very poor.

London Underground is continuing to evaluate the use of these cards as an intermodal link with the bus system. This is a point of concern under the existing pass arrangements. Period passes are issued as person specific proof of payment; however, with different ticketing systems for the bus and rail services, passengers would have to be issued two different tickets. Ensuring that the two were only used by one person would be quite difficult.

Netherlands Railway Smartcard Project

Public transportation in the Netherlands is provided by companies owned by the larger cities, by the "VSN Groep" (a holding company of regional bus companies), and by the Netherlands Railways (N.V. Nederlandse Spoorwegen, NS). In 1992, about 3 million passengers were carried each day, of which 900,000 (30%) were carried by NS. In 1980 the "strippenkaart" was introduced as an integrated ticket and tariff system for public transportation by bus, tram and underground. The strippenkaart is a ticket strip with a certain value, somewhat like a strip of stamps. Fares are distance based and hence validation of the strip cancels a value depending on the number of zones traveled. The cards do not provide information to determine the distance or number of zones traveled nor does it help in revenue allocation among the different companies. In 1984 a feasibility study was conducted to explore the use of a magnetic ticket. A prototype was developed and tested but rejected in 1986. In 1992 NS conducted a feasibility study for use of smart cards. The aim of the study was to establish whether paper tickets used for NS could be replaced by a smart card which would:

- combine tickets for bicycle sheds, parking facilities, and bus and train travel

- offer more suitable tariffs and provide better statistics for allocation of revenue

The evaluation focused on contactless cards, since they could be processed quickly (0.1 second). This speed seemed necessary to accommodate the great number of passengers (900,000 passengers per day). For instance, during peak hours, when fully loaded trains (approximately 1000 passengers per train) stop at a platform every 3 minutes, passengers also have to leave the platform within these 3 minutes. The NS Board of Directors authorized the specification phase in March 1993, and the specifications were finalized in June 1994.

CONTACT CARD APPLICATIONS

Dublin DASH Card Project

This was a three month pilot test which was launched in February 1994. The DASH card was used to pay for phone calls, parking, tolls or bus fares. The pilot test included 24 public telephones, 25 buses (on one route), one parking facility, and a toll road. The participating agencies considered it as a test to get experience in the institutional arrangements and accounting mechanisms for a multiple-function/multiple-service card. There were no commitments attached beyond the pilot test, though the agencies are currently evaluating the results of the trial and discussing their next steps.

The key reasons for selecting Schlumberger's contact card system were:

- The telephone company (Telecom Eireann) had experience with Schlumberger contact cards over four years
- They have been in use longer than contactless cards
- More suppliers are available for reader/writer units for contact cards
- There are more card suppliers
- The DASH card could be used as an electronic purse and is also programmed with:
- Weekly/monthly pass privilege
- Phone units
- Token values (free offers for promotions)
- Car parking season passes

Biel (Switzerland) POSTCARD Project

In northwest Switzerland, the city of Biel is entering its third year of an "electronic purse" demonstration. Currently, 30,000 people are using the contact smart card, which is called a POSTCARD. The sponsor of this project is the Post, Telephone, and Telegraph Service (PTT). PTT also runs over 2,000 buses throughout the nation. A POSTCARD can be acquired from a PTT office if one has a savings account with the PTT (a common practice). The POSTCARD is a smart card with a magnetic stripe to serve both technologies during the transition.

The card can be used:

- In 10 TVM's (Ascom) to purchase single and multiride bus tickets for local bus system (BVB). No PIN code is required.
- On 3 long distance bus lines.
- In 32 PTT public pay phones, which also allow value to be reloaded in the purse.
- In 25 reader/writers in stores to pay for goods and services (including McDonald's).
- In 3 cold and hot drink vending machines.
- In reader/writers at the post office to pay electric and telephone bills and to buy stamps.
- In 150 on-line terminals as a debit card in department stores and at railway station ticket counters. A PIN is required.

When the value in the card gets low, the holder can go to a PTT window and get value added. Eventually ATM's will be able to perform this add value function. The smart card keeps track of the latest transactions (the number of transactions retained in memory is a programmable feature). PTT maintains a central clearinghouse computer system to keep track of all electronic transactions. There are other TVM's in Biel for the Swiss Railroad (SBB), which sell tickets for the mountain railways and ski resorts. These TVM's accept debit payment from smart cards and bank cards and also accept credit cards. The magnetic stripe is used for bank cards and credit cards. These require a PIN number for all sales.

Chicago PCIS Project

The first attempt to use a contact card in a U.S. transit application was in 1992 with the Chicago Payment Control Information System (PCIS) for paratransit services. Funded by the Northeast Illinois Regional Transportation Authority (RTA), the PCIS project was planned to eventually involve 17,000 mobility-limited riders of paratransit services and 260 carrier vehicles in Chicago. Paratransit trips are provided by private carriers under contract with public transit authorities in the area. Rides are reserved ahead of time, and trip verification is currently recorded on paper trip tickets which must be submitted to the transit authority for reimbursement. Trip costs average $17.

PCIS was developed to meet the following RTA goals:

- Automate rider-carrier transactions and reconcile them against the existing reservation system.
- Prepare carrier payment, performance, and exception reports to improve the management of the growing paratransit operations.
- Introduce electronic identification technology to certify cardholder access to paratransit services, reduce unauthorized use, and decrease or eliminate duplicate or fraudulent billing.

Operation

Under PCIS, each paratransit vehicle driver would be assigned a portable, handheld computer capable of reading and writing to a smart card. The battery-powered terminal weighs about 19 ounces and would be carried by the driver in a holster. At the beginning of a shift, the driver would use a smart card to initialize the portable terminal, and then enter the registered vehicle number and the current odometer reading. Driver routes are dynamically scheduled by company dispatchers using two-way radios. Upon arrival at a pick up site, the starting mileage for the trip is entered by the driver. Data and time stamps are automatically added to the record by the terminal's internal clock. After a rider boards a vehicle, his/her smart card would be placed into the unit, which would identify and register the rider with a second time stamp. The arrival and boarding events are recorded separately, to provide a record of on-time performance. Fares can be paid in cash, with tokens or passes, using transfers — or can be deducted from the rider's card (if a stored value amount is being carried on the card). At the destination, the driver would enter the ending mileage, and the rider's card would be inserted again to time stamp the end of the trip.

When the vehicle and driver return to the garage at the end of a shift, both would be logged off the driver's handheld terminal. The terminal would then be inserted into an electronic cradle to recharge the battery and to prepare for polling activities. The PCIS central system would automatically telephone the cradles according to a set schedule and retrieve all ride data into the central database. As the portable terminals are polled, update lists would be sent from the central system to each unit. These updates would identify hot-listed cards or stored value amounts to be added to the electronic purse on a particular card.

Project Status

The PCIS central system was designed to automatically match electronic ride data against the reservation records retrieved from the existing reservation system. Any rides or reservations not

matched are listed would be exceptions for closer examination by program staff or auditors. Because the central system is a relational database, both standard reports and ad-hoc queries would be used to monitor carrier performance.

Although PCIS was fully developed and the equipment ordered, its field implementation has been delayed indefinitely due to quality control and engineering problems encountered with some of the portable terminals. Card costs were approximately $10/card in quantities of 300. Each terminal cost about $15 for 310 units.

APPENDIX B. NON-TRANSIT APPLICATIONS AND OTHER TECHNOLOGIES

NON-TRANSIT SMART CARD APPLICATIONS

Peanut Commodity Card

Women, Infants, and Children Program - EBT

State of Ohio Food Stamp Program

OTHER EMERGING TECHNOLOGIES

Long Distance Radio Frequency Tags

Laser Cards

Bar Coded Cards

NON-TRANSIT SMART CARD APPLICATIONS

Peanut Commodity Card

Of the U.S. smart card applications, only the Peanut Commodity Card, which uses a microprocessor-based smart card, has a track record (it has been in use for seven years) to provide adequate statistical results for a full analysis of the costs and benefits of the technology once in use.

In 1987 the U.S. Department of Agriculture initiated the Peanut Commodity Card project with the aim of reducing the amount of paperwork and the manual effort needed to administer the peanut price support program. Before this, the scheme had relied on paper marketing cards, provided by the USDA to each peanut producer. The cards gave information on the producer's quota. Each sale of peanuts was recorded on a 6-part sales marketing form. Delays and errors in processing caused the system to be less equitable than desired and the system involved a large amount of paperwork. The smart card therefore appeared to provide a solution to these problems.

Contact smart cards are now used by nearly 200,000 producers at over 500 local privately owned peanut buying points and provide an efficient method to record point-of-sale data. The smart card is distributed by the USDA to each producer and is encoded with the producer's quota and other relevant data. At the buying point a paper copy of a marketing form is provided for each transaction for each producer, the transaction is recorded on the producer's smart card, the quota balance is automatically adjusted, and a duplicate record is transmitted to a central database. At the end of the season the producer returns the smart card to the local county USDA office for reconciliation and correction of discrepancies.

By eliminating the paper marketing card and multi-part sales forms the original implementation cost of $12 million was recovered by 1990, and it is estimated that by 1996 the net savings to the U.S. government will be approximately $14 million dollars. Card costs in 1991 were $8.50/card in quantities of 30,000.

Women, Infants, and Children (WIC) Program - EBT

Electronic Benefits Transfer (EBT) applications will soon overtake the peanut card as the largest application of smart cards in the U.S. EBT provides for the electronic payment of government benefits. Proponents of EBT contend that it reduces fraud and paperwork, while improving productivity, timeliness, merchant access to funds, and the auditing process.

In 1991 Wyoming initiated a one-county test of the use of contact smart cards to carry food package benefits, in lieu of paper checks for WIC participants. The local WIC clinic encodes and distributes the smart cards. The card is encoded with the cardholder's personal identification data, a store number, up to 4 months of WIC benefits (food category and quantity) and space for the last 4 card transactions.

The cardholder presents the smart card in the checkout lane for the clerk to insert into the point-of-sale terminal and for PIN entry by the cardholder. The terminal performs a verification on the smart card such as checking against a hot list. Items eligible for the WIC program (as defined by the smart card) are totaled separately from the ineligible items. Each item must be scanned twice - once for the cash register and once for the point-of-sale terminal. The checkout clerk must also key-in the smart card debit amount.

A smart card reader with a printer is provided for the cardholder's use to determine the amount of benefit remaining and to obtain a list of items still eligible for purchase. The WIC state office system polls merchants for redemption data and clinic systems for insurance data on a daily basis. After transactions from the merchants are reconciled, payment is authorized to the merchant accounts through the automated clearinghouse.

In 1993 a contract was awarded to extend the program to half of the state and to include food stamp and health information on the smart card. Card costs were approximately $10/card in quantities of less than 1,000. The benefits of the program have been reduced merchant errors; faster reconciliation of accounts; less reliance on the store manager and checkout clerk remembering WIC eligible items; greater flexibility for the cardholder in allowing food purchases at any time during a month; and less WIC staff time in reviewing transactions. A disadvantage is the requirement for double scanning in the checkout line, but even so transaction time was not significantly longer than a typical purchase paid by personal check, food stamps, or WIC paper check.

State of Ohio Food Stamp Program

In 1991, the State of Ohio launched a federally sponsored demonstration test, using contact smart cards (in lieu of paper coupons) to carry food stamp benefits for redemption at food retailers. Roughly 11,000 food stamp recipients received cards to use in 93 food retailers in a single county. Although the Federal government has not yet released a final evaluation of the food stamp demonstration, Ohio, with the approval of the state legislature, issued a Request for Proposal (RFP) in February 1994, looking to expand the demonstration project statewide and add other benefit programs to the card.

Of significance in both the Wyoming WIC and Ohio Food Stamp expanded projects is (1) the dramatic increase in the number of individuals carrying smart cards; (2) the use of multiple applications, which helps in justifying the project costs; and (3) the required integration of the smart card into the store's Electronic Cash Register (ECR) system, to eliminate double scanning of products. The size and scope of the Ohio project (with the involvement of 7514 retailers with 11,085 check-out lanes) will, in particular, increase the incentive for key ATM and POS terminal manufacturers to upgrade their equipment for the smart card interface. The increased availability of such equipment has implications for the introduction of an intermodal/multi-purpose payment card.

OTHER EMERGING TECHNOLOGIES

Long Distance Radio Frequency Tags

Long distance radio frequency tags are miniature radio transmitters/receivers which communicate to a host terminal through an interrogator which may be up to 240 feet or more away. An interrogator is a relatively expensive radio transmitter/receiver which is typically mounted on poles or attached to ceilings. The interrogator may operate in a stand-alone mode or be networked to a host computer which controls and monitors interrogator activities.

Overview of the Technology

One prominent interrogator is smoke detector-sized and operates in conjunction with EEPROM, active (i.e., they contain a battery) tags with both read and write capabilities, and a memory capacity of either 1 KByte or 8 KBytes. This system is manufactured by Savi Technology. Another prominent system has a considerably larger and heavier interrogator. This works with passive tags, which have read-only capabilities, and vary in memory capacity. (The most widely used tag is in the 20 byte memory range.) This system is manufactured by Amtech. The data transfer rates with long distance frequency tags are normally high.

Current Application Areas

Because of the size and shape of long distance radio frequency tags (they are significantly wider than the ISO financial card standard), they are not conveniently carried in wallets. Hence, applications using this technology have been geared toward placing the cards on fixed objects, as for example in inventory control and toll collection. Savi's tags are being used by the Department of Defense in prototype testing for a variety of applications, including inventory tracking.

Amtech tags are being used for toll collection and identification of vehicles ranging from automobiles to trucks to railroad cars. On the Oklahoma Turnpike, for example, tag holders open an account with the authority and are able to bypass the toll plazas. Interrogators mounted above the highway send a signal to the tag, which responds with its unique serial number identifying the account holder. A high-speed computer associates the tag with a billing account and accumulates tolls for periodic billing of the account holder.

Other Developments

In October 1993, Amtech introduced a new electronic toll and traffic management/road-pricing system called "DyniCash." This new system combines Amtech's current high-speed vehicle/roadside communications technology with an ISO-compatible smart card. This allows the driver to pay tolls automatically, without stopping, from a prepaid store of funds on the card.

AT&T has teamed up with Mark IV, Inc. to create a reader/writer for electronic toll collection which contains an RF transmitter. Mounted on a vehicle's windshield, the device (known as FasTrak) can communicate to transponders along tollways or at the gates of parking lots to calculate and deduct a variable toll or fee from the card. There are a number of trials, experiments and pilot projects in progress in toll collection, parking fee collection, and other revenue collection applications throughout Europe. They include, for example, the GAUDI Project (Generalized and Advanced Urban Debiting Transactions), in which Dublin, Barcelona, Bologna, Marseille and Trondheim are participating.

Long-distance radio frequency tags are not considered viable options for a transit/multi-purpose payment media for the following reasons:

- The tags lack convenient portability.
- Both tags and interrogators are too expensive relative to their use for small change purchases.
- Tags require battery power for data processing.

Laser Cards

Laser cards may have potential in the transit sector — not for passenger use but for support functions such as storing maintenance and training information in a convenient manner.

Overview of the Technology

The laser card, which was introduced to the card technology market in the early 1980s, is a plastic card of similar thickness and size as a credit card. It belongs to the generic family of optical memory cards which require an optical technique to read and/or write to the card. Other members of this family include bar coded and holographic cards. The laser card is distinguished from contact cards and magnetic stripe cards primarily in that it has a large memory capacity — up to 6.6 megabytes (the equivalent of about 2400 pages of text); this allows the card to store image data as well as alphanumeric information.

The laser card uses a data recording method called WORM (Write-Once-Read-Many), in which laser light is irradiated by the reader/writer, forming pits (small holes) in the optical recording layer of the card. Data, once encoded on the card in this way, cannot be erased or modified. The stored data is secure, in the sense that it is a permanent audit trail of data additions and changes, unaffected by external factors such as magnetic fields or static electricity.

Unlike smart cards, the laser card does not contain a microprocessor. It is, instead, a passive recording media. The card has no internal protection against outside access of its database. This means the card can record unauthorized use, although it cannot, by itself, prevent that incursion. This has raised concerns that the optical card lacks the level of data security required to satisfy most commercial and government applications, particularly those involving financial transactions.

Current Application Areas

Laser cards are found almost exclusively in the health care arena at the present time, being used by public and private health practitioners, as well as third party medical equipment vendors. The capabilities of the laser card are especially attractive to the medical community because of its:

- Portability combined with a data capacity that can store many years of medical history per card.
- Immunity to accidental erasure and fraudulent changes.
- Its durability in even the harshest of environments.

Bar Coded Cards

Along with its smart card project (see above), Netherlands Railways also uses bar coded passes and "micro-wands" (hand-held bar code readers like those used by Federal Express couriers). The micro-wands identify misuse of passes by identifying "hot listed" numbers or overriding. This misuse is a particular concern with the pass programs, particularly student passes, "special" concession passes such as those for ex-employees and military personnel, and special corporate passes.

The student pass allows unlimited travel within certain zones. The pass program is administered by the Ministry of Education, which reimburses the railway for honoring the student passes. The program began in 1990 and about 600,000 students participate. The program became so popular that the students try to retain the benefits after they are no longer eligible. The "hot list" of ineligible passes quickly escalated at the rate of 2,000 per month and manual look-up of a 10-digit ID number by inspectors became infeasible. Over 22,000 numbers were on the "hot list".

Netherlands Railways (Nederlandse Spoorwegen, NS) started a twelve-month test with two types of equipment - a laptop unit with pen reader for bar codes and the micro-wand. Within six months, laptops were ruled out. They had more memory size, programming, and other features but they were inconvenient to use and disliked by the inspectors, who were in favor of the micro-wands. As of April 1994, over 50 inspectors were using these devices, on board the train, to check passes at random. About 7,000 passes are checked each day. The pass includes a photograph, human readable text, and the 10-digit ID number coded in interleaved 2 of 5 bar code symbols.

The bar code system improved the process of pass verification and reduced the size of the hot list considerably. It also led to a revenue increase. The Ministry of Education reimburses NS for each "documented" case of pass abuse. NS estimates that misuse costs between 2,500 and 3,000 Guilders per year, plus an additional 1,000 in legal costs if the case goes to court. The new equipment has helped reduce pass misuse.

APPENDIX C. RELATED RESEARCH AND DEVELOPMENT EFFORTS

ITS AMERICA ELECTRONIC PAYMENT SERVICES

ADVANCED PUBLIC TRANSPORTATION SYSTEMS

VNTSC COMMON TOLL AND FARE PAYMENT SYSTEM

FTA ADVANCED FARE PAYMENT MEDIA STUDIES

APPLICATION OF THE J-108 STANDARD

ITS America Electronic Payment Services

ITS (formerly IVHS) America in its *National IVHS Program Plan* (May 1994) advocated that the user-vision for Electronic Payment is of an intermodal multi-use smart card system linking electronic toll collection, transit fare payment, and parking payment. Before Electronic Payment can be deployed, key stakeholders must have tested, and be willing to invest in, their respective areas. For example, further development of electronic banking and the introduction of the IC chip card into the credit card and automated teller network industries will be instrumental. It is unlikely that Electronic Toll Collection (ETC) and fare collection can become integrated above the State level if IC chip card technology does not become widely used in personal electronic banking. Some States may independently seek compatibility between ETC, transit, and publicly administered parking facilities. Such compatibility may be promoted at the Federal level as part of the IVHS Systems Architecture effort.

Electronic Payment Services — Electronic Toll Collection, Electronic Fare Collection, Electronic Parking Payment, and Integrated Electronic Payment Services — will allow travelers to pay for transportation services with electronic cards or tags. The goal is to provide travelers with a common electronic payment medium for all transportation modes and functions, the link would be through an intermodal multi-use electronic "smart" card system. A common transportation service fee payment structure developed by a local Metropolitan Planning Organization (MPO) could be used with all modes, possibly tying into roadway pricing options.

The technologies involved in Electronic Payment Services focus on three main areas: Automatic Vehicle Identification (AVI) technology for electronic toll collection, parking payment, and road/congestion pricing strategies; smart card systems for transit fare collection, electronic toll collection and parking payment; and electronic funds management systems that will be used for support of the entire service.

Advanced Public Transportation Systems

The Advanced Public Transportation Systems (APTS) program has been created by the Federal Transit Administration (FTA) as a major part of the U.S. Department of Transportation (U.S. DOT) initiative in ITS. As a part of this program, an information database on the national applications of advanced technologies in public transportation is being developed. Operational tests of each technology are being undertaken. The operational tests serve as the transition between research and development and full-scale deployment of ITS technologies. A typical APTS operational test integrates existing technology, R&D products, institutional arrangements, public acceptance, and market readiness in a real world test bed.

Many of these projects and operational tests involve the integration of several different technologies. For example, to help the traveler make immediate decisions about his/her travel mode or route, a series of Smart Traveler technologies is being explored. Other applications, in Smart Vehicle Technology and Smart Intermodal Systems, are also being developed. A number of convenient fare payment options are being tested that may move transit towards a "cashless" operation. These options include the use of magnetic and smart cards. Examples of the tests planned under the APTS auspices include Ann Arbor's development of a mobility pass which will use smart card technology for transit and parking and Wilmington's use of prepaid smart cards (supplied by a local bank) for transit and other purposes.

VNTSC Common Toll and Fare Payment System

The FTA's objective is to develop a plan for a common standard card-based fare payment system which can be used for a multitude of public transportation modes including buses, subways, taxis and toll applications such as tunnels, bridges and roads. The desired result is increased ease and efficiency for users of multimodal and intermodal transportation systems and it is hoped that ultimately such a payment system may have broader applications including credit card purchases, vending machines, and telephones.

Under the auspices of this program, a consultant (Coopers & Lybrand) has recently reported to the FTA on the alternative stored read/write fare card technologies that can potentially be used for fare and toll payment. A description of the processes followed in this report and a summary of the conclusions follows.

There were three distinct tasks in the project. First, the existing read/write card systems technologies for fare and toll applications were surveyed, as were the existing and planned projects in this field and external factors which have an effect on the implementation of these toll or fare cards. The reviews led to the separation of the projects into two major categories:

- Person-based — where the fare is collected from an individual
- Vehicle-based — where a toll is collected from a vehicle

In the second task, system requirements were noted and transit agency personnel were interviewed to identify their unique requirements. Tradeoff analysis was used to allow the critical requirements to be matched with available alternatives. The final task outlined schemes for implementation and design characteristics.

The card technology alternatives were compared with the composite of person-based and vehicle-based requirements and it was determined that there is no available technology which fully meets all of the critical requirements of the two systems and that the ultimate selection of a technology will require further investigation of the tradeoffs between specific application requirements, equipment costs, and card system capabilities.

The vehicle-based systems were considered equally with the person based systems in the report, but here only the latter are discussed. The major factor which led to the separation of the two systems was the distance from the reader at which the card will be read, i.e., the read range must

be longer for the vehicle than the person based applications. The key requirements for a personbased system were defined as follows:

- Have a convenient size in order to fit into a standard wallet or purse
- Be durable enough to withstand bending and be able to resist common forms of external interference
- Be designed to minimize necessary user actions and to support simple and easy to follow procedures
- Be designed to maintain a certain level of reliability bearing in mind possible variations in user actions

The transit agencies were also concerned with efficiency and effectiveness of the overall system's operations, which implies that from the transit operators' perspective, the card must:

- Be low cost to support a high level of distribution
- Allow quick passenger throughput at reader stations
- Be a standard size to allow uniformity of reading equipment, both internally and for integration with external agencies and groups
- Support a high level of performance, particularly in terms of read reliability and information integrity

The prepaid card approach with read/write capabilities was preferred since :

- it is required to support distance based and peak travel pricing schemes, as well as other special pricing schemes such as modal transfers
- it retains anonymity of the user
- it does not require the agency to establish or maintain user accounts

Other card requirements were divided into six major areas — Information, Processing, Performance, User Interface, Interoperability, and Security Requirements — and the extent to which these features are critical for each mode was determined. It was recommended that, although the processing requirements could be handled within the card, these activities should be performed within the reader or in the local database instead, to keep the cost of the card low and remove the need to update the fare schedule on each card after each fare change. The RF (contactless) and the magnetic stripe systems performed best on the critical performance requirements (read distance, transaction speed, information integrity, and read reliability.) User requirements were thought to be of paramount importance in system design and hence the contactless solutions were preferred, since they are more appropriate for the paratransit applications and in general give a higher level of user convenience. Again, for user convenience an ISO sized card was recommended. A centralized approach to ID validation and transaction processing was not recommended with the present telecommunication infrastructure, since short validation and transaction processing times were considered critical performance requirements.

Establishing the financial collection reporting and distribution procedures for an integrated system was identified as one of the greatest challenges facing transportation agencies. The financial issue which raised the most concern from the agencies interviewed was the collection and distribution of shared revenue in an integrated environment. The report noted that the overall merit of the credit approach must be weighted carefully since in some cases the costs savings achieved through improvements in operational system efficiency are lost in the creation of a customer and account maintenance area.

FTA Advanced Fare Payment Media Studies

This project, which began in 1991, set out to review the Advanced Fare Payment Media (AFPM) options which are available in the market place, their feasibility in the transit field, and the requirements of the transit industry. In Phase I of the project, two different consulting firms (GLH and Echelon) identified a procedure for identifying the optimal choice of system for different transit properties; the approach recommended by one of the consultants (Echelon) was since adopted and small operational tests of a range of different options were subsequently conducted as Phase II. These tests were analyzed by the consultant to understand the true costs and benefits of each system. Based on the positive results of Phase II, Phase III was initiated to test contactless smart card technology on a broader basis. This phase, involving the use of the cards on the buses of the seven transit systems in Ventura County, California, was scheduled to begin in March 1996. Described below are the methods and findings of the Echelon Phase I report.

Methods and Findings

Technologies — The consultant reviewed the different options for technology, including those currently available and those which are still in the development phase. Costs as well as operational considerations were included in these reviews. The needs, concerns and priorities of the transit industry (see below) were also related to the available options, to ensure that there was sufficient grounds for belief that such AFPM's would be appropriate in the field. Four generic card applications for smart cards (Identification/Access, Transaction Log, Portable File (Data) and Electronic Payment) and other advanced fare payment technologies were identified.

Agencies — A survey of over 150 transit agencies was completed, followed by detailed discussions with a smaller group of agencies, to isolate the motivations for considering these AFPM options, the constraints on their introduction, and the relative importance of different

systems operating parameters. From this, four potential applications of the generic card options were identified, as follows:

- Corporate Card — for use in a bus pass fashion, with the ability to track individual employees, by route and time of travel.
- Basic Card — to act as a debit card, which could be charged periodically. Recharging or adding value to these cards through the ATM network would be more feasible as usage increased.
- Advanced Fare Card — An Automatic Vehicle Location (AVL) system would be connected to the on bus card readers to provide information about boarding and alighting locations.
- Passenger Transaction Systems — This option would be to include passenger sensors on the bus to record boardings and alightings for all passengers (since it is assumed that not all passengers will wish to make use of the prepayment options.)

Conclusions

The major conclusions of this study included the following:

- These systems could be used with considerable effectiveness to improve transit operations and planning. Passenger convenience could be improved, greater corporate involvement encouraged, and revenues increased from improved security.
- The systems could be applied to nearly all types of transit system.
- Consideration of an AFPM system depends in part on the agencies ability to provide data on ridership and rider classification, and hence those properties with ERF's might not be as enthusiastic about the AFPM as those properties relying on drop boxes.
- More revenue is lost through incorrect payment of fares than through theft fraud or counterfeiting.
- The importance of cost is greater for the smaller agencies than it is at the larger, though costs were noted as a major constraint to implementation by 83% of survey respondents. (It should be noted that no costs were assigned to the technologies in the survey and thus the agency was using its own "best guess" at systems costs for these rankings.)
- Other important requirements for a transit agency would be reliability, accuracy, security, and user acceptability. Other concerns mentioned in the face to face discussions with agencies included the recharging of cards, fraud prevention, and the ease of integration with existing systems.

The consultants concluded that all AFPM systems were suitable for any size of operation and hence a standard approach to evaluation based on the size of property and type of operation would be inappropriate. Rather, the choice of system by each property would be driven by the problems and needs to be addressed, not by the AFPM type.

Phases II and III

The consultant recommended comprehensive operational tests of each card type, on a small number of vehicles, for Phase II. Echelon developed bus card reader/writer units and installed them on buses at three transit properties in Southern California (LA DOT, Torrance, and Gardena). Echelon tested these units with contactless cards on some buses and contact cards on others. Contactless cards were found to be the most cost-effective option, and were very wellreceived by riders who used them. Based on the results of Phase II, a decision was made to implement the card reader units and a contactless card system on all buses operated by the seven transit systems in Ventura County; as indicated above, this program was scheduled to become operational in march 1996.

Application of the J 1708 Standard

Introduction

In the last few years, many transit agencies have incorporated a number of sophisticated electronic devices on-board buses in order to provide more information on the operating status of the buses. These "intelligent" vehicles coordinate the information on-board so that it may be shared by the devices and extracted by the agency every day. These devices include fareboxes, transfer issuers, ticket validators, destination signs, passenger counters, automatic vehicle location (AVL) systems, and stop annunciation systems, as well as a number of engine and vehicle component monitoring devices. While the benefits of the individual devices are evident, the greatest benefits are realized when the information is shared among the devices. For example, the AVL system would automatically determine the location of the bus, provide this information to the farebox and when the bus crosses the zone boundary, the correct fareset could be automatically selected, all without driver interaction.

As most of these on-board devices are manufactured by different companies, the interfaces are critical for ease of data collection, storage and transfer. An effective method to collect and store all the data generated on-board in a single device is needed, which would then transfer all the collected data to a designated computer system. A Vehicle Area Network (VAN) would be required to properly and efficiently manage and control the data flow between all on-board devices.

In 1992, under sponsorship of the FTA, acting as the lead agency for the APTS program, a committee was formed to develop open standards for communications between microcomputer systems in transit vehicle applications. The standard should allow for flexibility of on-board

systems design to provide for lower costs and to allow each agency to define the on-board systems more easily and consistently. The lower costs would depend on the ability of multiple manufacturers to develop the required devices, the interchangeability of those devices, and the possibility of upgrading by adding more devices to the VAN gradually. The flexibility and possibility of customization within the standard would accommodate differences between agencies.

The Standard

Rather than developing the standard "from the ground up" the committee identified an existing standard which could be easily adapted for transit vehicle applications. The standard which was chosen for this purpose was the Society of Automotive Engineers (SAE) J 1708. The SAE J 1708 is part of a family of standards which addresses the open integration of various devices, systems, and components used on heavy duty vehicles and trucks. The J 1708 standard defines packages of data that can be sent from device to device (up to 255 devices) over a simple twisted-pair, shielded copper wire and the communications parameters for both the hardware and software. The structure and contents of the data packages are defined in a separate standard. A level of priority is assigned to each of message so that the most critical messages are gathered first, while those less critical are gathered later by the on-board central controller. The process of developing the standard for the transit application has meant that criteria for Parameter Identification messages could also be included.

Implementing J 1708

The modifications to the J 1708 standard were accepted by the SAE in late 1993 and properties are just beginning to order the required J 1708 wiring and interface requirements as a standard feature for new buses. The operational flexibility and the wealth of information provided by these systems are the driving force behind agencies decisions to adopt the J 1708 standard. Though at present the changes in fare collection systems where the J 1708 standards are being adopted have been small, the potential is large, particularly for revenue security, for information on ridership levels and passenger trip patterns, for distance based pricing, and for employer billing systems.

For example, the AVL systems will identify the location of the bus and can automatically make changes to the destination signs or farebox information when a zonal boundary is crossed, or provide information for the stop annunciators when stops are being approached. In conjunction with automatic passenger counting systems, AVL will allow identification of passenger boarding and alighting points. AFC technology would than allow the number of fares paid at each stop to be compared with the number of boarding passengers as reported by the APC system. Any discrepancies will be highlighted and reported at the garage, to enhance revenue security and provide detailed planning information. Smart card technology will allow the passenger to be processed automatically, including identifying where the passenger boards and storing this information on the card, reading the information from the card as the passenger alights, calculating and deducting the fare, storing the new value and trip data on the card, and storing the data in the processor.

Some properties have recently acquired equipment which meets the J 1708 requirements and these are briefly described below.

Houston METRO — METRO initially retrofitted one vehicle with the J 1708 cabling as a test, and followed this with a commitment to retrofit all buses similarly. Presently, specifications are either prepared or being prepared for four different devices which would be implemented using J 1708. These four devices are the radio, passenger counters, AVL system, and stop annunciators. The specifications for the radio system (including Vehicle Logic Unit (VLU) and control head (keypad and display)) and the passenger counters have been completed and are out for procurement. The specifications for the other two devices are still in the preparation stage. A test on approximately 35 buses will be carried out once the stop annunciators and AVL systems have been implemented and before the rest of the fleet is equipped with these subsystems.

In June 1992, METRO awarded a contract to Cubic Corporation to procure new on-board equipment for their fare collection/verification system. This new system includes new fareboxes with ticket processing units (TPUs) and will provide stop-level data. This equipment provides the data for output to the J 1708 interface. In mid-1993, the equipment was installed on the buses at the Kashmere garage and tested. However, the testing of the J 1708 provisions were not included in this first test.

Baltimore MTA — The MTA has recently placed a small order (45 buses) with two different bus manufacturers. All of these buses will be equipped with the wiring and interface connections needed for J 1708 implementation.

For the past two years, the MTA has been testing the Loran AVL system on fifty buses. However, due to the limitations inherent in the system, the MTA has decided that a Global Positioning System (GPS) would best meet their needs. A notice to proceed will be awarded by the Summer of 1994. The GPS, which will have a resolution accuracy of 100 feet, will eventually be tied into the J 1708 on the new buses. The MTA is also equipping 25 present buses with automatic passenger counters which utilize a light beam. This feature will also eventually be incorporated into the J 1708 system.

New Jersey Transit — New Jersey Transit (NJT) has recently awarded a contract to supply 94 suburban buses and 224 transit buses. Prototypes of these buses were delivered to NJT in March 1994. A 60-day in-service test began April 1 and if successful, delivery of the remaining buses will be completed by June 30, 1994. All of these buses will be equipped with the wiring needed for J 1708 implementation. All new bus orders will also require J 1708 wiring. The connectors, however, will not be included as the on-board devices to be used have not yet been selected.

NJT has recently begun a program (the Alternate Bus Route Project) that will transmit information regarding the conditions on two parallel highways (the NJ Turnpike and Route 9) to allow the driver to take an alternate route if congestion dictates. The messages displayed to the driver on the possible alternate routes will be determined by the route on which the bus is

traveling. This information is stored in the fare register upon sign-on by the driver. Beacons will be installed at various points on the access roads to these two routes so that when a bus passes the beacon, the information regarding traffic conditions can be provided to the driver, using a transponder.

AC Transit — Technical Specifications have been recently prepared and a request for proposals was issued for new on-board fare collection equipment for the AC Transit system. These specifications specifically state that the fare collection equipment must be capable of providing an interface from the fare collection equipment to the J 1708 VAN. This is one of the first specifications where the requirement for J 1708 compatibility was expressly required.

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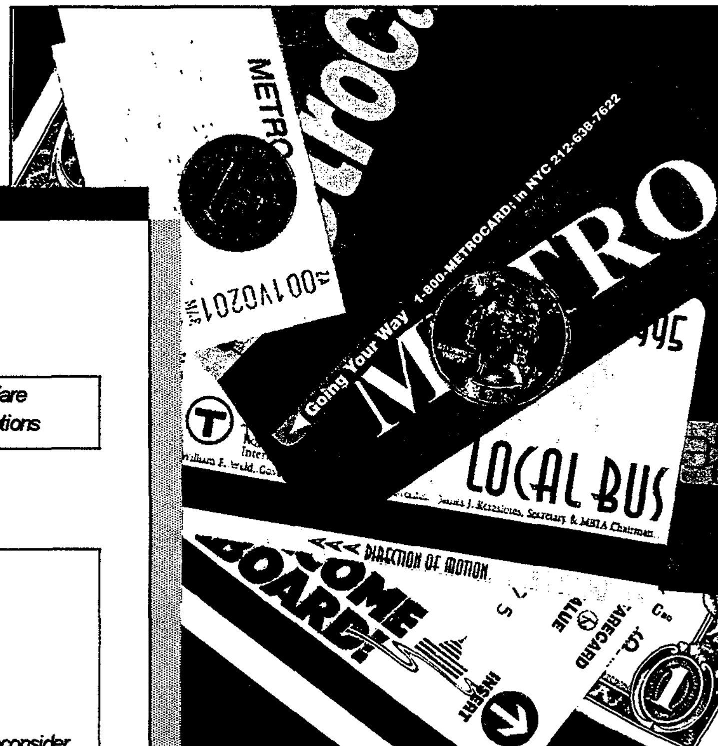
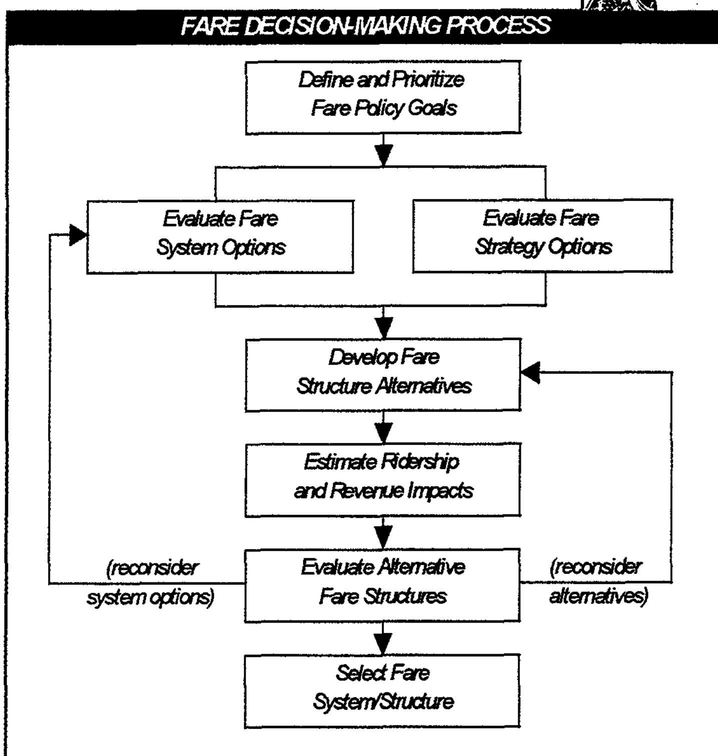
APPENDIX D

TRANSIT FARE DECISION-MAKING GUIDELINES

Transit Fare Decision-Making Guidelines





August 1995

Transit Cooperative Research Program

Transportation Research Board
National Research Council

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INTRODUCTION

BACKGROUND

As transit agencies seek to maintain, if not improve, their services in the face of tight fiscal constraints—and, in many cases, declining ridership—one of the major challenges they face is the establishment of effective pricing structures. The nature of the potential transit markets is changing (e.g., "suburbanization" is increasing and the numbers of elderly and persons with disabilities are growing), and these changes have been accompanied by an increasing realization by the transit industry that transit ridership is indeed made up of many different sub-markets. Market research has shown that these different sub-markets can be effectively targeted through differential pricing (i.e., market-based or consumer-based pricing), allowing riders to choose fare media (and perhaps levels) on the basis of their own travel needs and price sensitivity.

At the same time, these fiscal constraints also are exerting renewed pressure on transit agencies to seek better means to reduce the loss of revenue through fare evasion and abuse, and to improve revenue control in general. Moreover, the national emphasis on creating seamless transportation throughout a region is prompting increasing consideration of new mechanisms for creating integrated regional arrangements.

Fortunately, pursuit of these goals has been paralleled by new developments in fare collection and distribution approaches and technologies. These technological advances, including electronic (or automated) fare collection and distribution systems, have 1) facilitated the provision of a broader range of fare structures and instruments and a wider distribution network and 2) improved related functions, such as revenue control, data collection, operations planning, and fare integration (i.e., among different modes in a single system or among adjoining systems in a region).

Because of the fundamental changes in pricing structure made possible by electronic technologies, one of the chief impacts of the technological advances has been their influence on fare policy decisions. Whereas the practical constraints of the older fare collection equipment typically have limited the universe—and structural complexity—of fare options that a transit agency could consider, electronic systems offer an often unlimited array of options and provide a number of different options within a single system.

The primary advantage of electronic systems lies in the opportunity to tailor the fare structure to specific goals and objectives and to expand the role of fare policy. For instance, the flexibility offered by electronic fare collection could enable the transit agency to better match demand to available capacity (e.g., by effecting shifts of demand from peak to off-peak periods or from higher usage to lower usage modes through differential time-of-day or modal pricing). New technologies and approaches also offer possibilities to expand the revenue-generating potential of the transit agency, e.g., through usage charges associated with the sale of transit passes or farecards through automated teller machines. Meanwhile, electronic fare collection can further more traditional fare policy goals, such as revenue/ridership maximization, improved convenience, and improved equity.

On the other hand, the improved flexibility does not come without certain drawbacks. First of all, the new technologies can be quite expensive. In times of serious fiscal constraints, a transit agency must consider its ability to expend large portions of its capital budget on new fare collection and distribution equipment. It is therefore crucial that an agency clearly understand the costs and benefits associated with a new system. In addition, the flexibility and dizzying array of options afforded by the new equipment makes the development of a rational and cohesive fare structure much more complicated. Any agency implementing any advanced technology—and seeking to take advantage of its full capabilities—must go through a fairly detailed analysis effort. Therefore, guidelines for evaluating fare structures and technologies would be a useful starting point for such an effort.

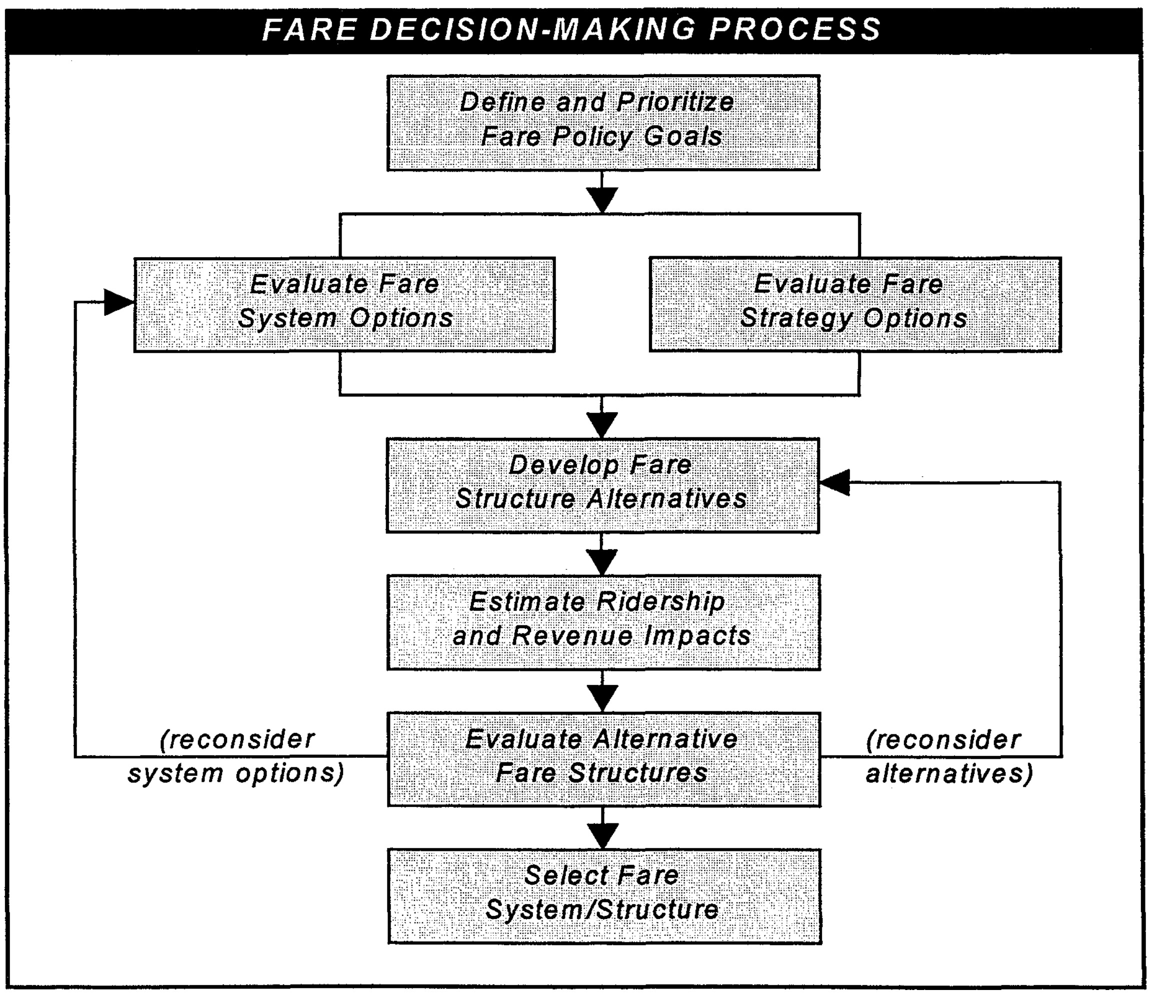
FARE DECISION PARAMETERS

There are essentially five fundamental parameters related to fare decisions: fare policy, fare strategy, fare structure, fare payment technology, and fare collection system. **Fare policy** is defined in a variety of ways; in the broadest sense, it is applied to all aspects of fare structure development, pricing, and selection of fare collection/payment methods. For this study, fare policy is defined as "the principles, goals, objectives and constraints that guide and restrict the management of a transit agency with respect to setting and collecting fares." **Fare strategy,** as used in this study, refers to "a general fare collection/payment structural approach;" possible approaches include flat fare, differential pricing (by distance traveled, time of day, or type of service), market-based or discounted payment options, and transfer pricing. The **fare structure** represents "the combination of one or more fare strategies with specific fare levels." **Payment technology** refers to "the type of fare payment media (i.e., cash, token, paper ticket, or advanced payment media) and equipment used for fare collection and sale/distribution of media." Finally, the **fare collection system** is "the basic fare collection and distribution approach, as well as the specific equipment and payment media"; the basic types of fare collection approaches are barrier, payment on entry, and proof of payment.

A transit agency must make decisions, at one point or another, about each of these parameters. Although each area typically is evaluated separately, they are interrelated and each decision ultimately affects decisions in the other areas. Policy generally sets the direction for the strategy and specific structure, but, as suggested above, technology choices can also affect the structure selected. Thus, it is useful to understand 1) the nature of options available in each parameter—those developments in use and emerging, 2) agency experiences in selecting and implementing different options, and 3) issues to consider in making fare-related choices.

FARE DECISION-MAKING GUIDELINES

This report provides guidelines designed to assist transit managers and staff in process of making decisions related to fare policies, structures and technologies. The basic steps in the overall fare decision-making process are shown in the accompanying exhibit. Obviously, not every transit agency will follow all of these steps in modifying its fare structure or selecting new fare collection equipment. Depending on the existing situation and the nature of the decision to be made, an agency may pursue only a small subset of this process—and the steps may not be in the exact order suggested here. For this reason, the major steps have been separated out in these guidelines. Thus, a transit manager need only consider those steps that are relevant to the decision at hand.



The decision steps shown above are summarized in this report, in the following order:

- **Define and Prioritize Fare Policy Goals**
- **Evaluate Fare Strategy Options**
- **Evaluate Fare System Options**
- **Develop Fare Structure Alternatives**
- **Estimate Ridership and Revenue Impacts**
- **Evaluate Alternative Fare Structures**

In addition, guidelines are presented for two "emerging fare technology developments":

- **Regional Fare Integration**
- **Multiple Use of Fare Cards**

For each step included, the researchers have outlined the basic options available, important inputs and considerations, and a summary of the decision process. In addition, because of the summary nature of these guidelines, each guideline identifies the location in the full TCRP Project A-1 Final Report (discussed below) of relevant details for that step.

TCRP PROJECT A-1 AND OVERVIEW OF THE FINAL REPORT

The guidelines presented herein are based on the findings of a comprehensive study carried out under the Transit Cooperative Research Program (TCRP). This study, TCRP Project A-1, examined the state-of-the-art and emerging developments related to fare policies, structures, and technologies. The project included the following key elements:

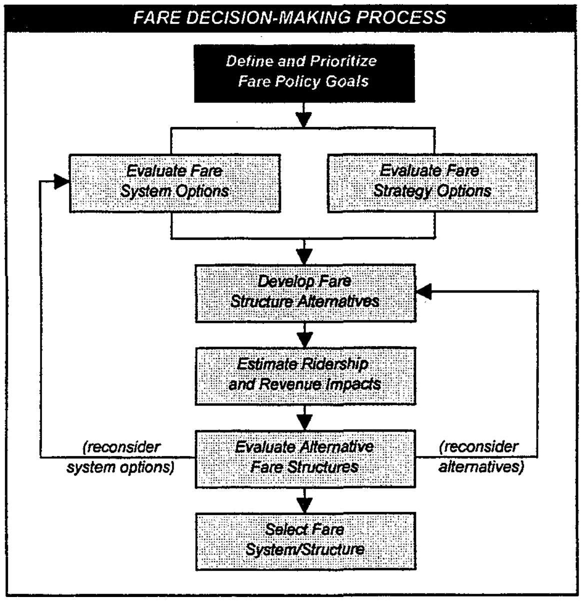
- **Initial Review:** a review of current fare policies/structures and types of fare payment and collection technologies at transit agencies of various sizes in the United States, as well as selected cases in other countries

- **Case Study Analysis:** case studies of the decision-making process and results of the development of fare policies, modification of existing fare structures, and selection of new technologies and equipment at 12 U.S. transit agencies (of varying size and modal orientation)

- **Review of Technology Trends and Developments:** a review and assessment of emerging trends and developments related to fare payment/collection technology; this effort included a review of electronic fare payment applications (i.e., magnetic stripe and smart card technologies) around the world, as well as emerging developments such as regional fare integration, multiple use of fare cards, post payment, and electronic funds transfer

The detailed findings of the study are presented in the TCRP Project A-1 Final Report. As indicated above, the guidelines presented here identify the locations of details on the different decision steps and inputs. Although these guidelines and the accompanying published report will not provide answers or solutions to all fare-related questions or problems, they provide suggestions as to the appropriate approach a transit agency should take—and issues it should consider—in making fare decisions.

DECISION STEP: DEFINE AND PRIORITIZE FARE POLICY GOALS



Identify Fare Policy Goals (see highlighted area of exhibit at left):

- customer-related goals
- financial goals
- management-related goals
- political goals

Inputs/Considerations:

- existing fare policy/structure/ media
- ridership trends
- revenue needs/funding situation
- legal requirements (e.g., for fare recovery ratio)
- need/pressure to integrate with other operators
- system size

Location of Details in Final Report:

- discussion of fare policy goals established by various transit agencies: Chapter 2
- case study examples of goals: Chapter 4 and Case Study Report
- goals and expected benefits related to new technologies: Chapters 2, 6, 8

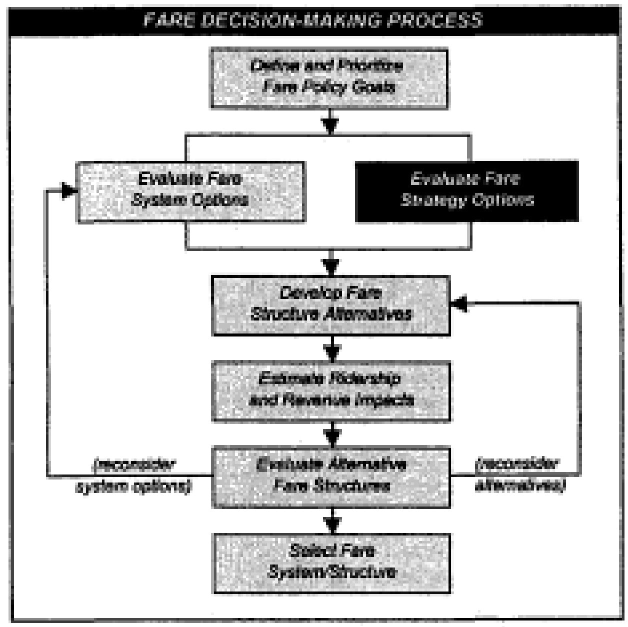
GOALS AND EVALUATION CRITERIA		
	Evaluation Criteria	
Policy Goal	Strategy	System/Technology
Customer-related		
increase ridership/ minimize revenue loss	impact on ridership	
maximize social equity	impact on equity	
increase ease of use (i.e., convenience)	convenience/ ease of use	convenience/ ease of use
increase fare options	range of options	
reduce complexity	complexity/ease of understanding	
Financial		
increase revenue/ minimize ridership loss	impact on fare revenue	
reduce fare abuse and evasion	impact on fare abuse/evasion	security (re duplication, impact on abuse)
improve revenue control		accountability (re revenue control)
reduce fare collection costs (administrative/operating)	impact on fare collection costs	cost of media, equipment, facilities
increase prepayment/ reduce use of cash	impact on prepayment	
Management-related		
improve data collection		1
improve modal integration	2	
increase pricing flexibility		flexibility (re adding options)
maximize ease of implementation	ease of implementation	
improve fleet/demand management	impact on fleet/ demand mgmt.	
improve reliability of fare equipment		reliability of technology
improve operations (i.e., maximize throughput)		operations impact (on throughput)
Political		
maximize political acceptability	political acceptability	
achieve recovery ratio goal/requirement	3	

1 - any technological improvement will likely improve data collection

2 - related to actual pricing of options and transfer policy

3 - related to actual pricing of options

DECISION STEP: EVALUATE FARE STRATEGY OPTIONS



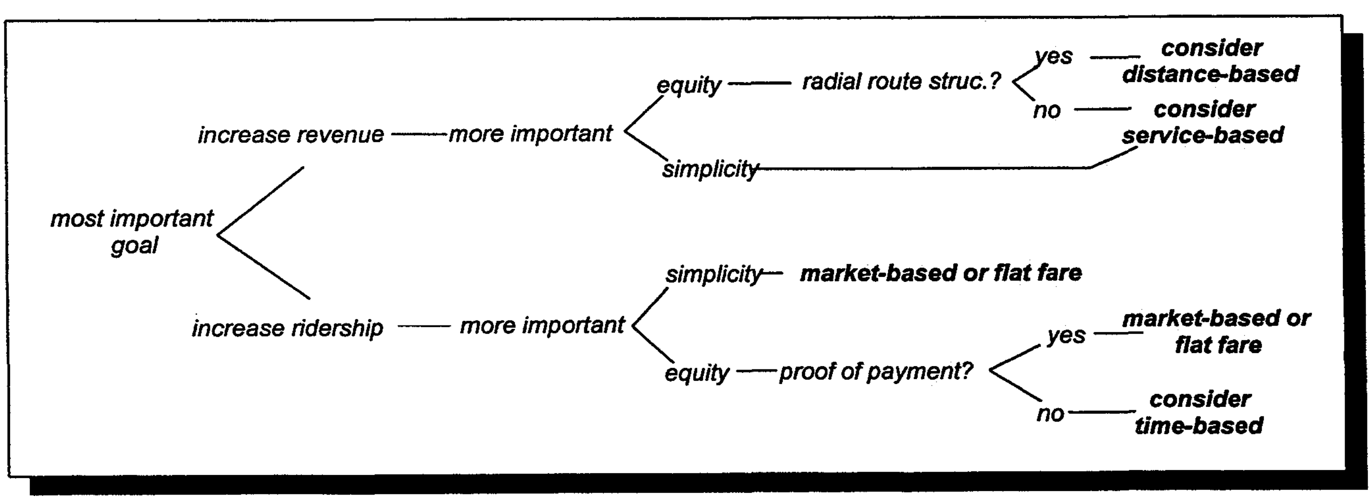
Basic Fare Strategy Options:

- flat fare
- distance-based or zonal
- time-based (e.g., peak/off-peak)
- service-based (e.g., express bus surcharge)
- market-based (e.g., multiple passes; prepaid discounts)

Inputs/Considerations:

- goals/criteria (and weighting)
- existing fare structure
- existing fare collection system (e.g., barrier vs. proof-of-payment)
- existing fare technology and options being considered/planned
- mode(s)/size of system
- orientation of routes (e.g., radial vs. grid)

Decision Process:



DECISION STEP: EVALUATE FARE STRATEGY OPTIONS (CONT.)

Location of Details (in Final Report):

- definition and discussion of strategies: Chapter 3
- evaluation process: Chapters 2, 4; see exhibit below
- consideration in case studies (overall): Chapter 4; Case Study Report

FARE STRATEGY EVALUATION MATRIX (UNWEIGHTED)

Evaluation Criteria	Weight	Ratings of Fare Strategy Options: Flat Fare	Market-Based	Distance-Based	Time-Based	Service-Based
Customer Criteria						
impact on ridership	1	2	3	1	2	1
impact on equity (e.g., redistributive effects)	1	1	3	3	2	2
convenience (i.e., ease of use)	1	2	3	1	2	2
range of options	1	1	3	1	2	2
complexity (i.e., ease of understanding)	1	3	2	1	2	2
Financial Criteria						
impact on fare revenue	1	2	1	3	1	3
impact on fare abuse/evasion	1	1	1	3	2	3
impact on fare collection costs (administrative/operating)	1	3	1	1	2	2
impact on prepayment (i.e., reduced use of cash)	1	1	3	2	2	2
Management/Political Criteria						
ease of implementation (e.g., marketing, training)	1	3	2	1	1	2
impact on fleet/demand management	1	2	2	2	3	3
political acceptability	1	1	3	3	3	2
Total Score		22	27	22	24	26

Rating Key: 3=High, 2=Medium, 1=Low

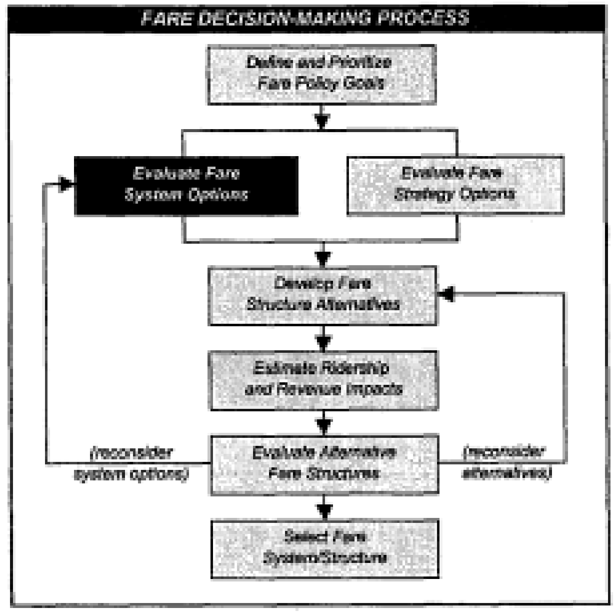
ADVANTAGES/DISADVANTAGES OF ALTERNATIVE FARE STRATEGIES

	Fare Strategy Options				
	Flat Fare	**Market-Based**	**Distance-Based**	**Time-Based**	**Service-Based**
Advantages	-Easiest to understand -Simplest and least expensive to implement and administer -Lowest level of fare abuse	-Generally considered equitable; offers ability to pay less -Can make fare increase politically acceptable -Can minimize ridership loss with fare increase -Maximizes prepayment -Most convenient option	-Should produce greatest revenue -Considered equitable; longer trip has higher cost	-Should increase ridership -Allows management of fleet usage through shift to off-peak -Considered equitable; commuters pay more	-Relatively easy to understand -Considered equitable; higher quality or higher priced service has higher cost -High revenue potential; low fare abuse -Allows management of fleet usage through shift between services
Disadvantages	-Places inequitable burden on those making short trips -Increase will cause greatest loss of riders	-Generally produces least revenue -Potentially high level of fare abuse -Requires extensive marketing to maximize ridership -Highest media production and distribution cost	-Difficult to use -Difficult to implement and administer; may require special equipment -Potentially high level of fare abuse -May be unpopular with users with long trips	-Potential for conflicts with drivers -Potential for fraud (agents on rail) -May require equipment modifications (or new equipment)	-May be unpopular among users of higher cost service -Complicates transfers (e.g., may require payment of "upgrade" fare in transferring)

DECISION STEP: EVALUATE FARE SYSTEM OPTIONS

Identify Major Goals/Impetus for Change:

- reduce fare collection cost
- improve revenue accounting
- reduce fare evasion/abuse
- improve flexibility
- improve convenience
- integrate with other operators



Identify Equipment Options and Functional Requirements:

- automated fare collection turnstiles (heavy rail)
- electronic registering farebox (ERF)(bus)
- ticket processing unit (TPU)/bus ticket validator/transfer issuing unit (bus)
- swipe reader—for magnetic stripe passes (bus, heavy rail)
- smart card reader (bus, heavy rail)
- automated vending machines (bus, heavy rail, light rail)

Identify Costs and Benefits of Alternatives:

- types and number of each type of equipment
- unit costs (based on number required)
- additional operating/maintenance costs
- potential cost reductions and other benefits

DECISION STEP: EVALUATE FARE SYSTEM OPTIONS (CONT.)

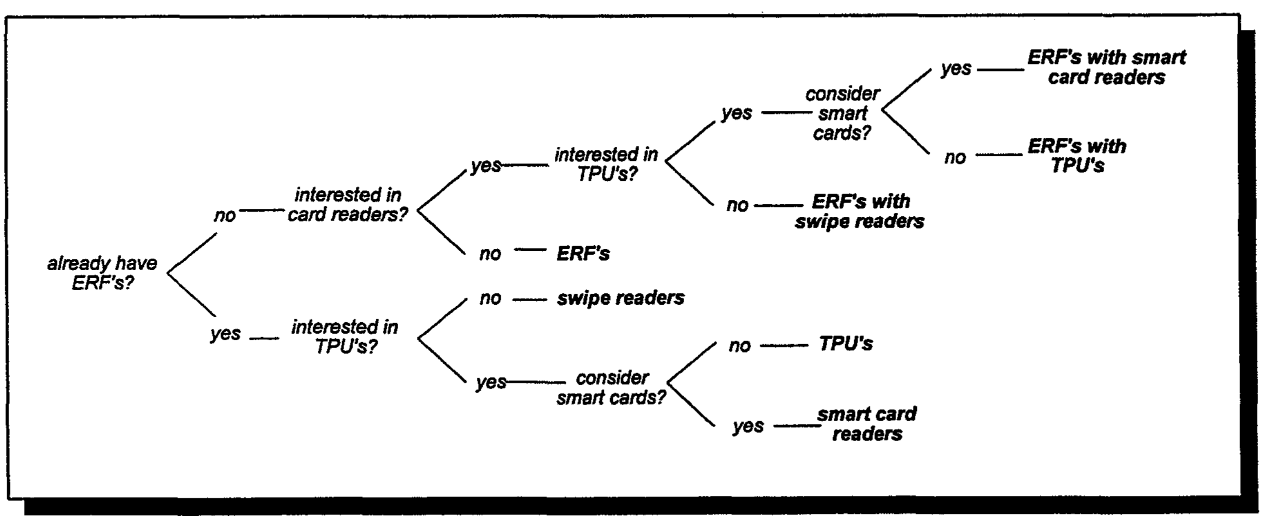
Inputs/Considerations:

- evaluation criteria/weighting
- budgetary constraints
- nature of existing (and planned) fare structure (e.g., zonal)
- existing technology/equipment
- concerns regarding reliability of new equipment

Locations of Details in Final Report

- technology options: Chapters 5, 6, 7; see following exhibit
- costs: Chapter 8
- benefits: Chapters 6, 7, 8
- evaluation process: Chapters 6, 8
- technology selection process: Chapters 6, 8

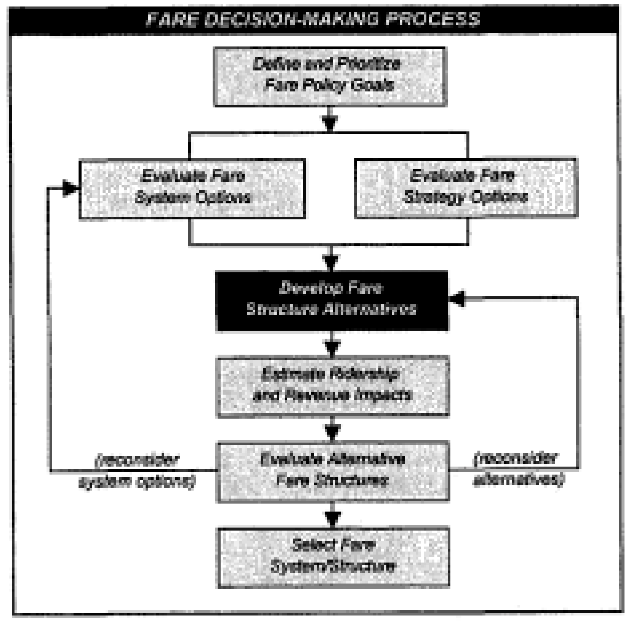
Decision Process (regarding upgrading bus fare collection technology):



CHARACTERISTICS OF CARD TECHNOLOGIES			
Criterion	Magnetic Stripe	Contactless	Contact
convenience	must be inserted or swiped	very convenient; hold near target	must be inserted
privacy	less of a concern than with smart cards	concern*	concern*
security	moderate	high*	high*
throughput	depends on format, lower than contactless	highest	lower than contactless
data capacity	up to 0.2KB	up to 8 KB	up to 8 KB
standardization	stds. exist (for stripes)	none	standards exist
operating experience	considerable, but bus TPU's still in tests	tests in number of sites, but no long-term exper.	limited transit, extensive non-transit experience
unit cost of media (transit application)	$0.10-$0.60	$3-$15 **	$3-$10 **
operating cost impact	highest equipment maintenance cost	lowest equipment maintenance cost; longer life for cards	longer life for cards than magnetic stripe

** assumes card has microprocessor, if not, roughly equivalent to magnetic stripe card*
***with microprocessor*

DECISION STEP: DEVELOP FARE STRUCTURE ALTERNATIVES



Identify Major Impetus for Change:

- increase revenue
- increase ridership
- reduce complexity
- maximize prepayment
- integrate new mode
- increase flexibility (i.e., take advantage of electronic fare payment)
- reduce administrative/ operator requirements (e.g., related to transfers)

Identify Fare Structure Options:

- vary (raise or lower) cash fare, pass prices, prepaid discounts
- introduce new fare payment options (e.g., prepaid discount, weekly pass, stored value card)
- introduce (or remove) fare differentiation (e.g., peak/off-peak differential, zone surcharges, express surcharge)
- modify transfer policy/price

Develop Alternative Scenarios (see following exhibit):

- establish fare structure options
- establish preliminary fare levels for each option

Fare Element	Current Structure	1) large cash and pass increase	2) large pk cash incr., pk/off-pk, deep disc.	3) small cash increase, deep disc.	4) small cash incr., pk/off-pk, deep disc.	5) cash same, higher pass price, wkly pass	6) simplified, (single cash fare/pass), deep disc.
	PRELIMINARY FARE STRUCTURE SCENARIOS						
Cash							
local (full), peak	$0.75	$1.00	$1.00	$0.85	$0.85	$0.75	$1.00
local (full), off-pk	-	-	$0.75	-	$0.75	-	-
senior	$0.15	$0.50	$0.25	$0.20	$0.20	$0.15	$0.25
disabled	$0.25	$0.50	$0.35	$0.30	$0.30	$0.25	$0.25
student	$0.25	$0.50	$0.35	$0.30	$0.30	$0.25	$0.25
express (full)	$1.75	$2.00	$2.00	$1.85	$1.85	$1.75	$1.00
LRT	-	$2.00	$1.00	$0.85	$0.85	$0.75	$1.00
transfer	free	free	free	free	free	free	free
Prepaid							
pass (full) month	$23.00	$35.00	$30.00	$26.00	$26.00	$26.00	$30.00
pass (full) week	-	-	-	-	-	$8.00	-
breakeven rate (mo.)	30.7	35.0	30.0	30.6	30.6	34.7	30.0
express pass month	$54.00	$70.00	$60.00	$57.00	$57.00	$60.00	$30.00
express pass week	-	-	-	-	-	$18.00	-
breakeven rate (mo.)	30.9	35.0	30.0	30.8	30.8	34.3	30.0
senior pass month	$5.00	$15.00	$7.00	$5.00	$5.00	$5.00	$7.00
disabled pass month	$8.00	$15.00	$10.00	$8.00	$8.00	$8.00	$7.00
commuter card, local	11 @ $7.50	10 @ $9.00	10 @ $7.00	10 @ $6.50	10 @ $6.50	10 @ $7.00	10 @ $7.50
% discount	9%	10%	30%	24%	24%	7%	25%
commuter card, express	11 @ $17.50	10 @ $18.00	10 @ $13.00	10 @ $14.00	10 @ $14.00	10 @ $16.00	10 @ $7.50
% discount	9%	10%	30%	22%	22%	9%	25%
student punch card	20 @ $5.00	20 @ $10.00	20 @ $7.00	20 @ $6.00	20 @ $6.00	20 @ $5.00	-
	40 @ $10.00	-	-	-	-	-	-
student pass (mo.)	-	-	-	-	-	-	$7.00
three-day pass	-	$6.00	$6.00	$6.00	$6.00	$6.00	$6.00
Demand-Responsive							
DRT, peak	$1.00	$2.00	$1.25	$1.50	$1.50	$1.00	$1.50
DRT,offpeak	-	-	-	$1.00	$1.00	-	-

DECISION STEP: DEVELOP FARE STRUCTURE ALTERNATIVES (CONT.)

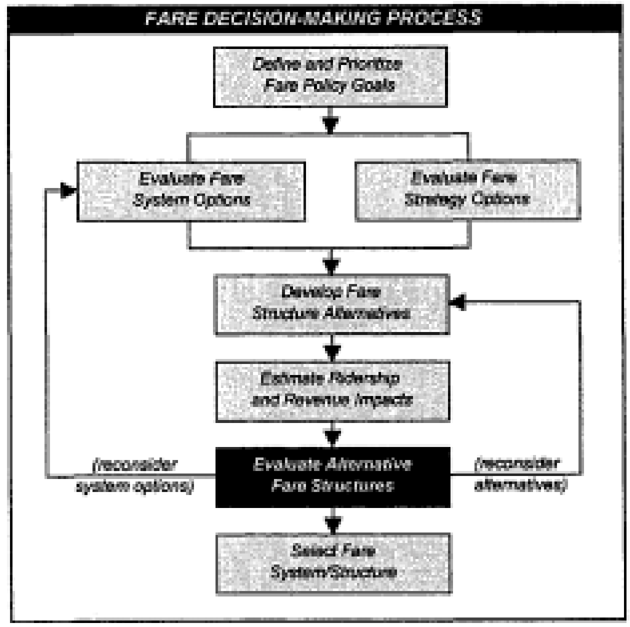
Inputs/Considerations:

- existing media/fare payment options
- new fare payment options to be considered
- nature/limits of existing fare collection equipment
- existing and new modes of service
- other constraints (e.g., related to legal challenge, implementation/schedule concerns)

Location of Details in Final Report:

- description of fare payment options, including advantages/disadvantages: Chapters 3, 6
- case study examples of development of alternatives: Chapter 4, Case Study Report

DECISION STEP: ESTIMATE RIDERSHIP/REVENUE IMPACTS



Develop Ridership/Revenue Model:

- compile baseline data (i.e., ridership, revenue, and average fare by fare type and mode—or other segmentation)

  4select modeling approach (e.g., using spreadsheet or econometric analysis) and complexity (e.g., based on systemwide versus market segment elasticities)

- identify/develop fare elasticities (based on regression analysis of ridership trends, before-after analysis of past fare change, use of a demand function based on survey results, and/or review of industry/peer agency experience; also apply professional judgement)

- develop model to estimate shifts among fare options, use of new fare options, and future system ridership and revenue

Estimate Ridership/Revenue Impacts of Fare Structure Alternatives:

- test ridership/revenue impacts of alternatives

- vary fare levels to determine relative impacts

Inputs/Considerations:

- capabilities of existing fare model (flexibility to consider new fare options, effectiveness in predicting impacts of past fare changes)

- nature of fare options under consideration (e.g., simple fare change versus introduction of new options)

- quality and extent of ridership/revenue data available

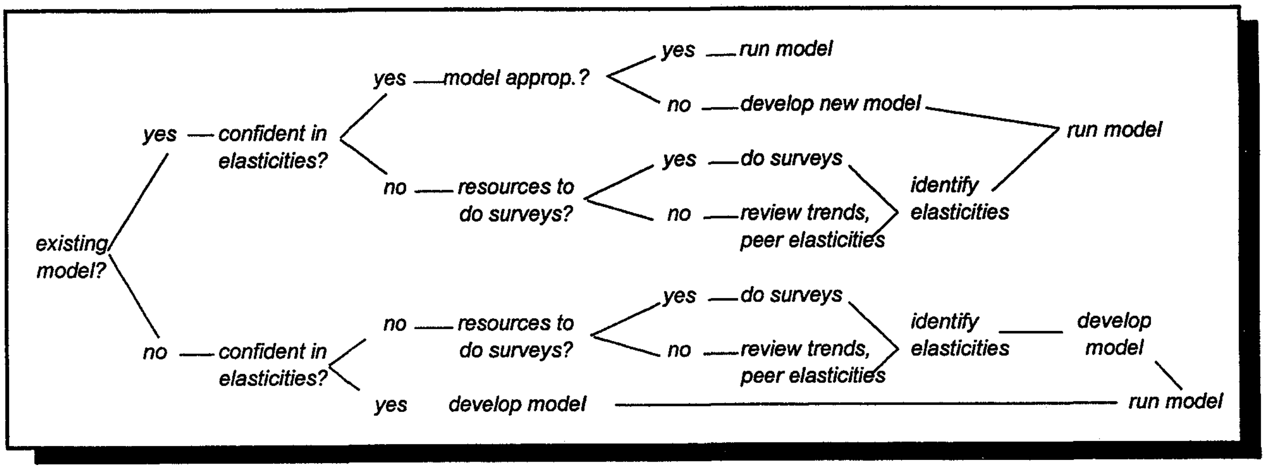
- confidence in existing elasticities

- resources available to develop/update elasticities and model (staff capabilities and/or funds for consultant)

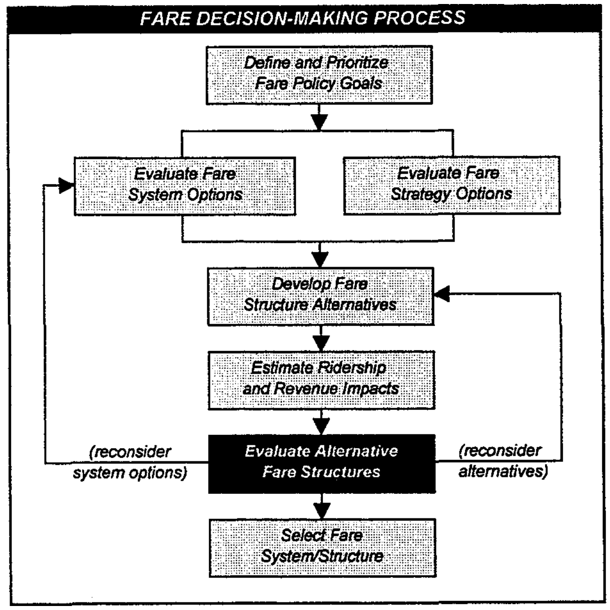
Location of Details in Final Report:

- development of elasticities and fare models: Chapter 4, Case Study Report
- identification of past ridership/revenue trends: Chapter 4

Decision Process:



DECISION STEP: EVALUATE ALTERNATIVE FARE STRUCTURES



Establish Evaluation Methodology:

- identify evaluation criteria (quantitative and qualitative)
- assign relative weights to criteria, based on local priorities (e.g., maximize ridership vs. maximize revenue vs. balance ridership and revenue)
- develop decision measures/ evaluation guidelines for the individual criteria (see exhibit next page)

Evaluate Alternative Fare Structures:

- develop preliminary alternatives, including different fare levels (see separate Decision Step sheet)
- test ridership/revenue impacts in Fare Model (see separate Decision Step sheet)
- develop and test new alternatives, as appropriate
- construct evaluation matrix, and rate/rank alternatives (see exhibit)
- identify short list of fare structure alternatives, and consider further (present to Board or public)
- recommend new or modified fare structure

Inputs/Considerations:

- fare policy goals and priorities
- implementation and marketing requirements
- schedule constraints

Location of Details in Final Report:

- definitions of typical evaluation criteria: Chapters 2, 3
- discussion related to establishing a weighting scheme: Chapter 3
- case study examples of criteria and weighting schemes: Chapter 4, Case Study Report
- case study examples of evaluation methodologies: Chapter 4, Case Study Report

EVALUATION CRITERIA -- DECISION GUIDELINES

Evaluation Criteria	Measures/Guidelines	Comments
Quantitative		
Maximize revenue	actual % change from current	from Fare Model
Maximize ridership	actual % change from current	from Fare Model
Qualitative		
Acceptable to the public	-1=large cash increase 0=no change 1=deep discount	reflects extent of public opposition/acceptance; "0" if large inc. and deep discount
Equitable in terms of impacts on different market segments	-1=higher % inc. for key mkts. 0=no change, or small impact 1=positive impact for key mkt.	key mkt. seg.: sr, dis, low income; "0" if higher % inc. for some, pos. impact for others
Convenient for riders	-1="inconvenient" cash amount 0=no change 1=add'l. prepayment options	additional prepayment options: deep discount, weekly pass; inconvenient cash is other than $.75 or $1
Simple to understand, easy to administer	-1=additional options 0=no change 1=no expr. surcharge or pk/off-pk	additional options: weekly pass, day pass, peak/off-peak; these are difficult to administer

FARE STRUCTURE SCENARIOS - EVALUATION (WEIGHTED)					
Evaluation Criteria	Weight	A1) $0.75 cash, Pass increase, Deep discount	A2) $0.75 cash, Pass increase, Week pass, Day pass	A3) $1 cash, Deep discount	A4) $1cash, Week pass, Day pass
Maximize ridership	10	-1.1%	-0.9%	-7.0%	-8.2%
Maximize revenue	10	4.9%	3.4%	13.0%	15.1%
Public acceptability	8	8	0	0	-8
Equity	4	0	0	0	0
Convenience	8	8	8	8	8
Simplicity of use, ease of admin.	8	0	-8	0	-8
Total Score, Qualitative Measures		16	0	8	-8

Base rating key: *-1 = worse/less than current structure*
0 = generally same as current structure
1 = better/greater than current structure

Weighted rating (Qualitative Measures only) = base rating X weight

EMERGING DEVELOPMENT: REGIONAL FARE INTEGRATION

Goal: to achieve "seamless" transit travel within a multi-operator region

Options:

- technology-based approach (i.e., common stored value fare medium); example: TransLink program in San Francisco Bay area
- non-technology-based approach (e.g., uniform fare/transfer structure and/or regional pass); example: San Diego region

Implementation Steps (technology approach):

- establish lead agency (i.e., MPO or largest transit agency)
- establish inter-agency revenue allocation/distribution methodology and agreement
- identify acceptable common fare medium and fare collection technology (including means to integrate proof-of-payment systems)
- acquire/install new equipment (each participating operator does independently)

Implementation Steps (non-technology approach):

- establish lead agency (i.e., MPO or largest transit agency)
- establish uniform fare structure (including transfer agreements) if feasible
- establish regional monthly pass if feasible
- establish inter-agency revenue allocation/distribution methodology and agreement (for transfers)

Location of Details in Final Report:

- discussion of concept, options, and requirements: Chapter 7
- description of examples of current efforts: Chapter 7, Appendix A

EMERGING DEVELOPMENT: MULTIPLE USE OF FARECARDS

Goal: to expand usage of fare media beyond transit (e.g., for telephone calls, use in vending machines, and/or use in parking lots)

Benefits to Transit Agency:

- expand ridership base by adding cardholders who are not current transit users
- reduce fare media production/distribution costs (if program administered by outside entity) or generate additional revenue (if program administered by the agency)

Technological Requirements:

- stored value fare medium, also known as "electronic purse" (usually done with smart cards)

Institutional Arrangements:

- transit agency administers (directly or through joint venture), and fare card is made available for other uses; examples: NYMTA, Manchester (England), Dublin (Ireland)
- bank or other private entity administers, and bank card can be used for transit fare payment; examples: Wilmington (DE), Biel (Switzerland), Copenhagen (Denmark)

Implementation Steps:

- identify lead agency (i.e., transit agency, joint venture, or private entity) and establish revenue allocation/distribution methodology and agreement
- identify/implement fare medium and fare collection technology
- establish fare structure for transit (must consider implications of purchase/use discounts on non-transit purchases)

Location of Details in Final Report:

- discussion of concept, options, and requirements: Chapter 7
- description of examples of current efforts: Chapter 7, Appendix A

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