PB98-109788

WORKSHOP ON EMERGING FARE COLLECTION TECHNOLOGIES IN MASS TRANSIT

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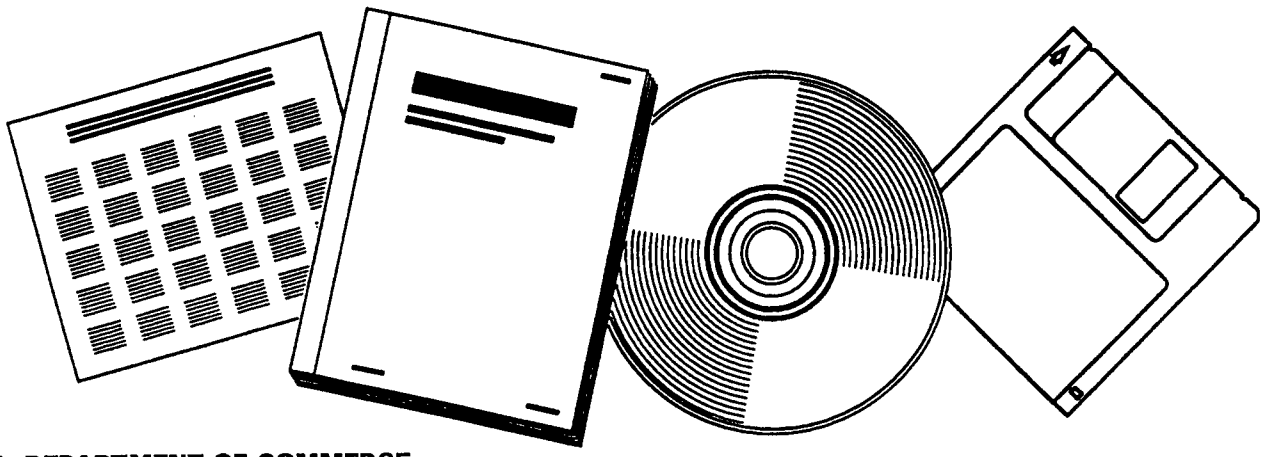

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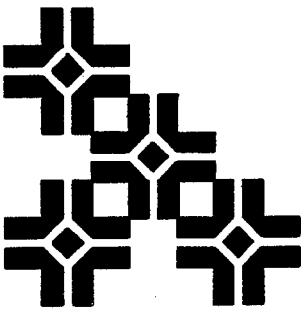
National Technical Information Service

PB98-109788

Workshop on Emerging Fare Collection Technologies in Mass Transit



National Urban Transit Institute

at the University of South Florida's Center for Urban Transportation Research

A consortium with · Florida State University · Florida A & M University · Florida International University

Exhibit C

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16. Abstract

The proceeding contains papers presented at the Workshop on Emerging Fare Collection Technologies in Mass Transit held in Miami, September 26-27, 1996. The objective of the workshop is to provide a forum for the exchange of ideas and development in emerging fare collection techniques in Mass Transit.

This workshop constitutes the combined efforts of the Lehman Center for Transportation Research at Florida International University, Center for Urban Transportation Research, the authors, keynote speakers, to whom goes the greatest recognition.

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Foreword

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Special thanks goes to Mr. Matt Coogan who was the keynote speaker, Mr. R. Rebeiro the luncheon speaker, Dr. Steve Polzin of CUTR, Dr. David Shen of FIU and Mr Ed Colby Director of Metro Dade Transit.

The project was supported by a grant from the U.S. Department of Transportation, University Research Institute Program.

I feel personally indebted to all of the people and agencies who helped make this conference a great success. I thank each and every one of you.

Nii O. Attoh-Okine
Organizer

Smart Card Fare Collection Players
An Overview

Prepared by:

R. Scott Rodda
BOOZ·ALLEN & HAMILTON INC.

For

Workshop on Emerging Fare Collection
Technologies in Mass Transit

Florida International University
September 27, 1996
Miami, Florida

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Workshop on Emerging Fare Collection Technologies in Mass Transit

Understanding the fare collection supply industry used to be simple. There were only a few manufacturers worldwide who produced equipment for either magnetic or paper ticket systems. Gates were magnetic and sometimes took coins and tokens. Ticket machines were well understood and the application of credit and debit was even easy to comprehend. The advent of smart cards changed this picture considerably. There is a whole series of new types of players such as:

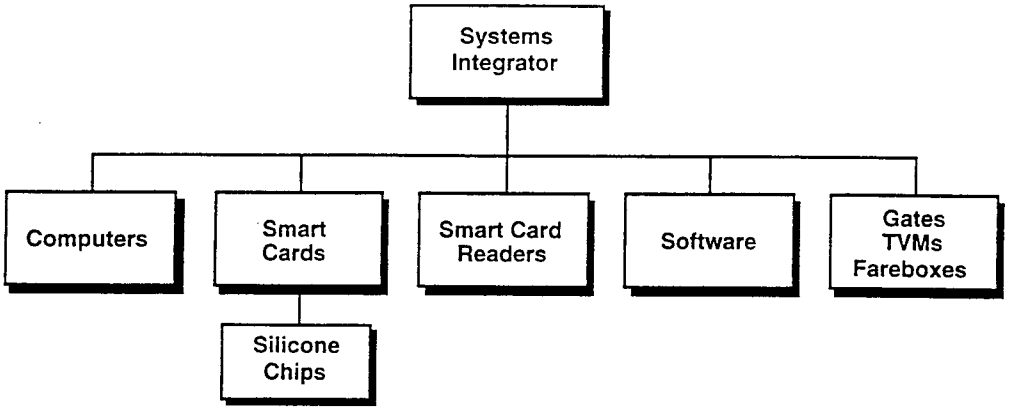
- System integrators
- Smart card manufacturers
- Chip designers
- Chip manufacturers

There are also new concepts to memorize like: contact vs. contactless, read/write range, open vs. closed systems, RF data transfer, etc. ANSI and ISO have existing and emerging standards for smart cards. There is a lot to learn to keep abreast of smart card market dynamics. This paper concentrates on defining the types of players and also provides a brief description of the most prominent ones in today's market.

System Integrators

System integrators typically operate as the prime contractor and design the complete system. Although there have always been system integrators to serve as prime contractors, smart cards in transit have made this term even more popular. With a pure smart card application, the prime contractor can play the role of a coordinator and simply purchase equipment and integrate it into a complete system. When the system includes other pieces of equipment such as gates, ticket vending machines, etc., the role of systems integrator would likely be assumed by one of the traditional prime contractors in the fare collection industry. Exhibit 1 is a simplified diagram of the elements that typically go into a smart card system. The box on the right hand side lists optional equipment that may or may not be included.

EXHIBIT 1
ELEMENTS OF SYSTEMS INTEGRATION



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Smart Card Manufacturers

Smart card manufacturers purchase the components that make up a smart card and assemble these into the final product. Components include silicone chips, antennas, plastic, and for contact cards the contact pad. They typically write the smart card operating software and manufacture the smart card readers.

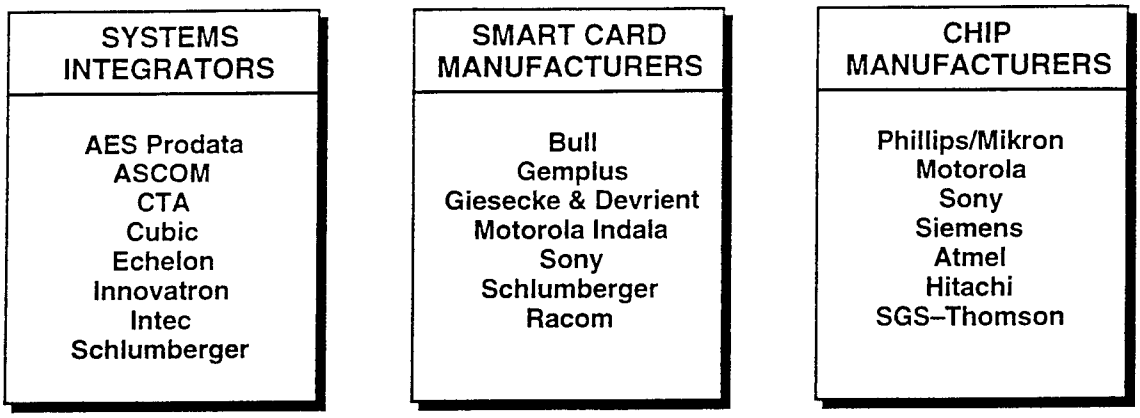
Chip Manufacturers

Chip manufacturers generally design the circuitry and layout of the smart card chip based on specific user needs and the standards of the industry. They manufacture the chip and usually place it into a module to protect it. Even placed into the module, the size of the chip is still small enough to go between the plastic layers of the smart card and stay within the approximate thickness of a credit card.

Player Profiles

Within the categories above, there are some players who have been in the fare collection business for quite some time and others who have entered the scene only recently. In an emerging industry such as this, the competition is fierce due to the perception that there is a large new untapped market. Shown in Exhibit 2 is a categorized list of many of the players presently in this market. Note that some players such as Schlumberger and Sony fit into more than one category. Provided below is a description of some of the players listed in Exhibit 2.

EXHIBIT 2
SMART CARD PLAYER CATEGORIES



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AES Prodata

This company is headquartered in Australia and provides a wide variety of fare collection equipment. They pioneered contact smart cards for transit applications in the 1980's. They have continued their marketing of smart cards and now have many installations of contactless smart cards. Current and planned installations include: Manchester, Hong Kong, Melbourne, Gothenburg and Toronto.

Ascom

Ascom has its headquarters in Switzerland and specializes in full service ticket vending machines. Their ticket vending machines are installed throughout Europe and in many other parts of the world including the United States. Their subsidiary company, Monetel, in France has developed a contactless smart card system. This system is installed on buses in Valence, France.

Cubic

Cubic is headquartered in California and has a full line of fare collection equipment. Their equipment includes ticket vending machines, gates, fareboxes and smart card systems. Their smart card system is known as the Go-Card and has been demonstrated in London and Washington. In Chicago, they are installing a magnetic ticket system which will also have smart card capability. Initially, the smart card system will be used by employees and later they will have the option to open it up to regular passengers. In Washington, they are now installing a completed Go-Card system for use on the subway, buses and at parking lots.

Schlumberger

With headquarters in France this company builds ticket vending machines and provides contact smart card systems. Schlumberger is also a major producer of smart cards for the banking industry. They have had several contact smart card applications in transit and may introduce a contactless system in the near future.

Gemplus

Gemplus is located in France and is the leading producer of smart cards in the world. They supply these cards to a wide variety of industries including: toll collection, banking, telephone and data storage. They have the contract to provide smart cards to the largest transit contactless application in Seoul, Korea. They were also one of the producers of smart cards for the Atlanta Olympics.

Giesecke & Devrient

This company is located in Germany and specializes in high security printing including bank notes for foreign countries. They also have a line of currency processing equipment and bill validators. One of their most recent products is contactless smart cards. They are currently providing the smart cards for Lufthansa's ticketless travel program. These cards will be good for other uses such as telephones. They also produced smart cards for the Atlanta Olympics.

Motorola Indala

This company is U. S. based and manufactures smart cards. Another division of Motorola designs and manufactures chips. They are about to launch a college campus contactless application. Early in 1997, they expect to enter the transit market with a combination card using one microprocessor.

Sony

Sony is headquartered in Japan and is represented by Mitsubishi in the United States. They manufacture chips and smart cards. In transit, they have large programs in Hong Kong and Tokyo and demonstrations in Seattle and Singapore.

Mikron

This company is headquartered in Austria and has a unique design for contactless smart cards. Having been recently purchased by Phillips, the combination of the two companies now includes capabilities of designing and

producing smart cards. Mikron's contactless chip design has been widely used in transit applications in Oslo, Seoul, Liverpool, Sydney, and Denmark.

Racom

Based in the United States, Racom specializes in contactless applications. They have an interesting contract at the new Hong Kong airport to provide smart cards to employees. Each smart card will have two electronic purses, one for employer covered purchases and one for personal use by the employee. In transit, they have applications in Ventura County, Toronto, Chicago and at the French National Railways.

Conclusion

Smart cards are now being used for many applications throughout the world. Their entry into transit has been slow especially in the United States. However, the advantages of contactless smart cards for transit are significant and over the long run they should make an appreciable market penetration. As demonstrated by the listing of the players, there are a lot of companies competing for the transit business. The number of system integrators will grow as the applications grow. The number of chip and smart card manufacturers may dwindle depending on the way the standards emerge and whether the volumes allow this to be a profitable market.

SMART CARD FARE COLLECTION

An Overview
for
Workshop On Emerging Fare Collection Technologies In Mass Transit

Florida International University
Miami, Florida

September 27, 1996
San Francisco, CA
R. Scott Rodda

BOOZ·ALLEN & HAMILTON INC.

CONTENTS

- Introduction
- Advent Of Smart Cards
- Who Are The Players
- Player Profiles
- Conclusion

UNDERSTANDING THE FARE COLLECTION SUPPLY INDUSTRY USED TO BE EASY

- A few major manufacturers worldwide
- Tickets were either magnetic or paper
- Gates were magnetic and sometimes took coins and tokens
- Ticket vending machines were well understood
- Even credit and debit features were simple to comprehend

THE ADVENT OF SMART CARDS CHANGED THE PROFILE CONSIDERABLY. WE NOW HAVE:

- Systems integrators
- Smart card manufacturers
- Smart card reader manufacturers
- Chip designers
- Chip manufacturers
- Software designers

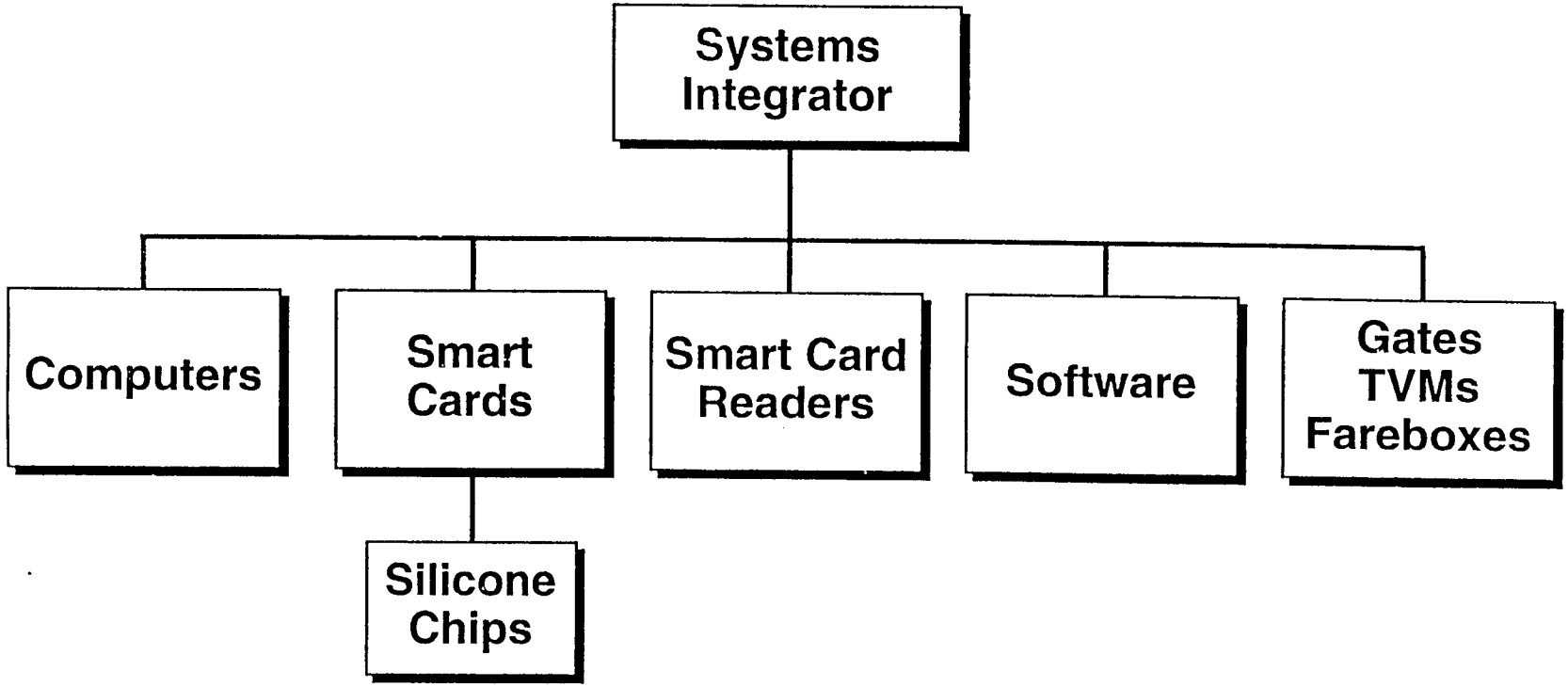
THERE ARE ALSO A COMPLETE SET OF NEW TERMS TO MEMORIZE

- Contact
- Contactless
- Close couple
- Read/write range
- Combination cards
- Memory cards
- Microprocessor cards

THERE ARE ALSO EXISTING AND EMERGING ANSI AND ISO STANDARDS FOR SMART CARDS

SYSTEMS INTEGRATORS GENERALLY PLAY THE FOLLOWING ROLE

- Act as prime contractor
- Design the overall system
- Purchase material and equipment from others
- Manufacture a portion of the hardware
- Sometimes write the software


Systems Integrator
Computers
Smart Cards
Smart Card Readers
Software
Gates TVMs Fareboxes
Silicone Chips

SMART CARD MANUFACTURERS GENERALLY FIT THE FOLLOWING PROFILE

- Purchase chips from Silicone manufacturer
- Design the smart card including antenna layout, etc.
- Manufacturer smart card readers
- Write chip software
- Work with systems integrator to design card graphics

CHIP DESIGNERS GENERALLY FIT THE FOLLOWING PROFILE

- Based on system needs and emerging or existing standards, they design the silicone chips
- Manufacturer smart card chips
- Manufacturer chips for readers
- Sell chips to smart card manufacturers

THE PLAYERS INCLUDE:

SYSTEMS INTEGRATORS	SMART CARD MANUFACTURERS	CHIP MANUFACTURERS
AES Prodata	Bull	Mikron
ASCOM	Gemplus	Motorola
CTA	Glesecke & Devrient	Sony
Cubic	Motorola Indala	Siemens
Echelon	Sony	
Innovatron	Schlumberger	
Intec	Raycom	
Schlumberger		

AES PRODATA

- Headquartered in Australia
- Pioneered contact smart card applications in mid 1980s
- Recent contactless installations and new orders include:
  - Manchester, England
  - Hong Kong
  - Melbourne, Australia
  - Gothemburg, Sweden
  - Toronto, Canada

ASCOM

- Headquartered in Switzerland
- Specialize in full service ticket vendor machines
- Subsidiary Monetel has developed a contactless smart card system
- Monetel's equipment is installed on buses in Valence, France

CUBIC

- Headquartered in California
- Have complete product line including
  - TVMS
  - Gates
  - Fareboxes
  - Smart cards (Go-card)
- Demonstrated Go-card in London and Washington
- New magnetic system in Chicago includes smart card capability
- Plan to fully implement Go-card in Washington

SCHLUMBERGER

- Located in France
- Serves as systems integrator and smart card manufacturer
- Produces cards for banking industry in England
- Took part in public transit trial in Dublin Ireland
- So far specializes in contact cards

GEMPLUS

- Headquartered in France
- Has the largest share of the smart card market worldwide
- Varied applications include:
  - Toll collection
  - Banking
  - Telephone
  - Data storage
- Transit applications include:
  - Chicago
  - Los Angeles
  - Seoul

GIESECKE & DEVRIENT

- Located in Germany
- Specialize in high security printing including bank notes for foreign countries
- Also produce currency processing equipment
- Supplied smart cards for Olympics in Atlanta
- Are providing the smart cards for Lufthansa's new ticketing system

MOTOROLA INDALA

- Located in the United States
- Another division of Motorola manufacturers chips
- About to launch a college campus contactless application
- Will have a combination card next year for transit with single chip

SONY

- Japan based
- Design and manufacture chips and manufacture smart cards
- Transit applications include:
  - Tokyo
  - Hong Kong

MIKRON

- Located in Germany
- Design and manufacture chips
- Transit applications include:
  - Oslo
  - Seoul
  - Liverpool
  - Sydney
  - Denmark

RAYCOM

- Based in the United States
- Specialize in contactless applications
- Have contract at new Hong Kong Airport
- Transit applications include:
  - Ventura County
  - French National Railways
  - Toronto
  - Chicago

CONCLUSION

- Smart cards are here to stay in transit
- Smart cards have opened new doors to integration
- Standards are still emerging for contactless smart cards
- The players are still evolving
- Combination cards should play a key role in the future

New Developments and new Market Segments for Contactless Smart Cards

July, 1996

Friedrich Plankensteiner

Mikron GmbH, Austria
a Philips Semiconductors Company

1 Introduction

The first complete volume installations of Contactless Smart Cards are finished and in full operation (e.g. 8700 buses in Seoul and all Lufthansa domestic gates in Germany are installed) and MIFARE® Contactless Smart Card technology has proven to the world that this technology is available and works reliable in volume applications.

It took a long period of time until the radio frequency identification technology (RFID) was able to come up with cards which are comparable to the existing Chip Cards in aspects of dimensions, functionality and security. Now the technology of Contactless Smart Cards is mature and adds to the convenience of the existing technologies the obvious advantages

such as typical read/write distances of about 10 cm, huge potential in reduction of maintenance costs at read/write devices and shorter transaction times for any type of application.

Specially this development was the main reason for the huge growth of Contactless Smart Cards in transportation applications, which are now going to spread out to other (satellite) applications like road toll, campus cards and airline ticketing (e.g. Lufthansa).

New developments will further lead to a high acceptance of Contactless Smart Cards in various applications and will combine applications using Contact Smart Cards (e.g. banking) with applications using Contactless Smart Cards (e.g. public transport).

2 Advanced Security Concepts for Contactless Smart Cards

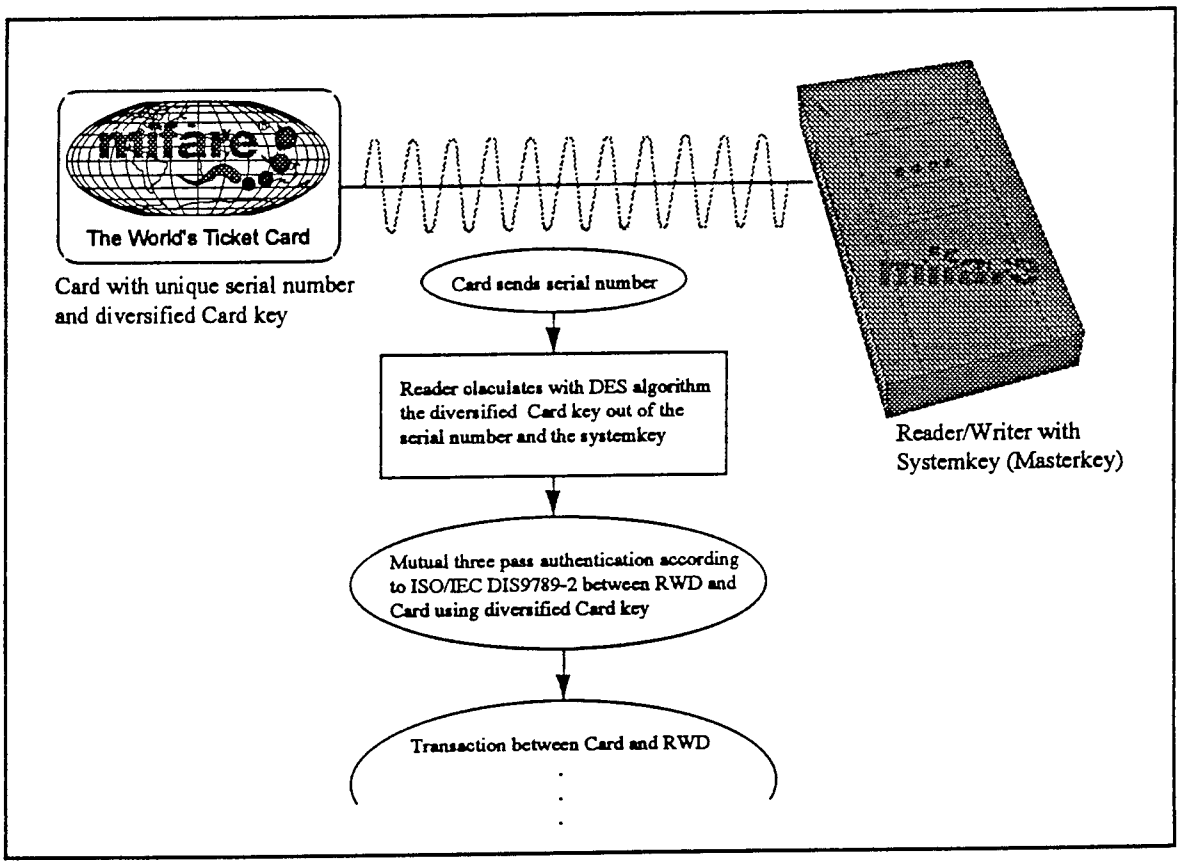
The required transaction speed for Contactless Smart Cards for a typical transaction is about 100 ms for a full transaction including verification, transaction log etc. Assymetric algorithm with public key cryptography like RSA are too slow (≈1 s) to achieve this goal. This leads to the conclusion that symetric algorithm are best suited for Contactless Smart Cards.

As symetric algorithm require to store the secrete key in the card, anyone having a card is caring the system key. However, the keys in the cards are stored in secure write only sections of the memory, which is also mechanically secured by putting the connections to the memory in one of the first layers of the silicon process.

The MIFARE® read/write devices are supporting a key diversification which secures that any key stored in a single Contactless Smart Card is unique and the read/write device has a master key to access the different Cards in a system.

Technically, the key diversification is achieved by making use of the unique serial number of each Smart Card which, together with the master key in the reader, leads to the unique security key stored in the Contactless Smart Card memory. The concept goes even one step further and offers not only one diversified key. The key stored in the Card for each file on the Card is different and even accessible with the same masterkey. The high sophisticated cryptoprocessor in the MIFARE® read/write device is using triple DES cryptography to handle the diversified key as well as the data transfer between reader/writer device and the host.

Although it is very unlikely that someone breaks into one card (it needs several hundreds of years doing that with brute force), the damage to the system is in any case limited using a diversified key, because all what the thief can break into is the key to one card and not to the entire system. After detecting fraud going on with a card the card issuer has only to put this card on the black list and eliminate this particular card from the system without changing the information (keys) in all the cards out in the field, which would cost an enormous amount of money for the card issuer and inconvenience for the system users.



Picture 1: Principal of the key diversification concept

In addition to all the sofisticated security functions, MIFARE® is also offering a trippel DES enchryption for the stored Data on the Card.

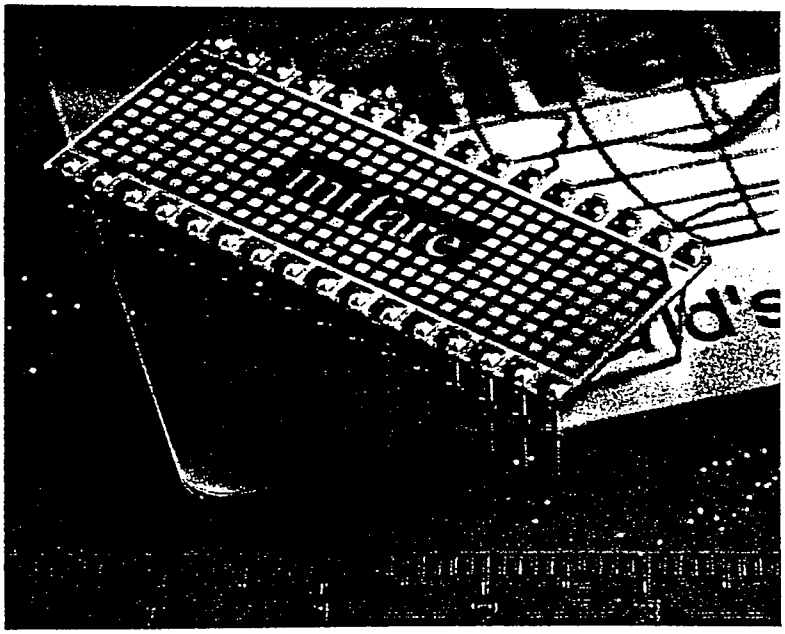
3 Micro read/write devices for Contactless Smart Cards

To meet the requirements of applications like parking meters and public telephones, a small and cost efficient read/write device is necessary.

The MIFARE® micromodule (MMM) exactly meets the above described requirement. Its dimensions of 40x17x8 mm with DIL pinning are ideal to get it integrated in any phone or parking meter just like regular contact based reader/writer devices. Thanks to its special design the system integrator even does not have to tune the RF-antenna and will get a read/write distance of about 20 mm.

The module also needs only a 5 V power supply what is a necessity for a battery powered handheld read/write device.

Together with a PCMCIA (Type II) interface Card a MIFARE® Contactless Smart Card read/write device which consists only of a micromudule and a RF-antenna PCB can be built. Also, this solution is also ideal for access control in computer networks and for payment purposes for example in the internet.



Picture 3: MIFARE® MMM Read/write device

4 MIFARE® Plus Card (Combi Card)

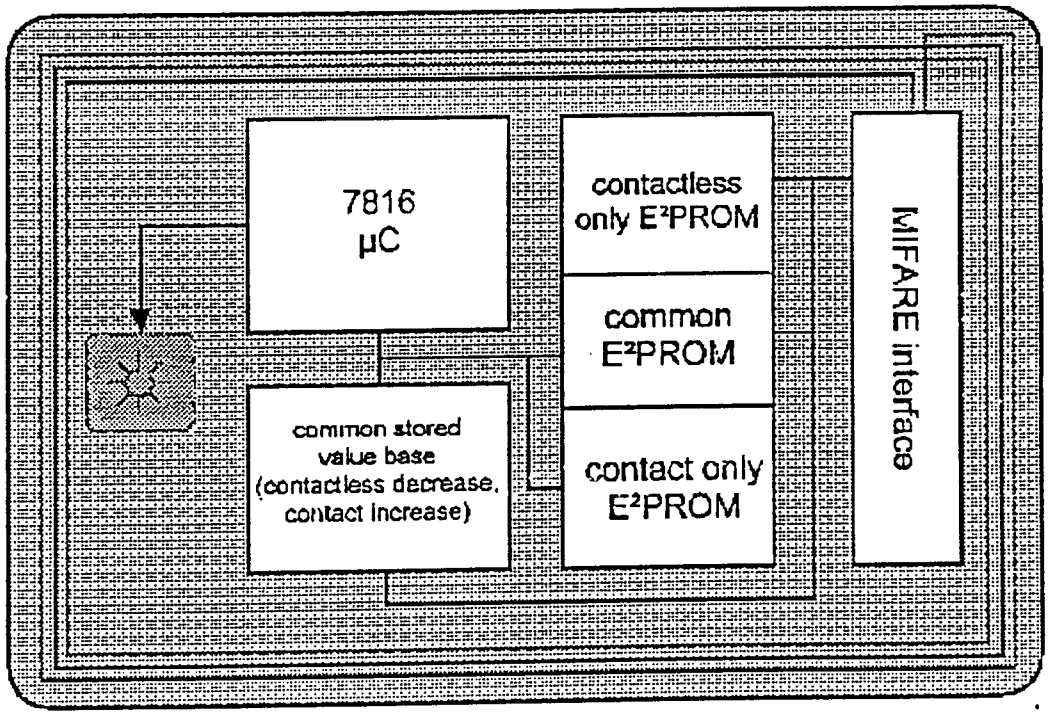
The MIFARE® Plus Card is developed to combine the advantages of using an existing contact card infrastructure with the speed and convenience of a MIFARE® proximity card. The new Combichip consists of a Smart Card chip with a contact interface (conforming to ISO 7816), as well as a MIFARE® interface that is fully compatible with all MIFARE® read/write devices.

4.1 Technical Concept

The technical product concept is open to different microprocessor cores and accepts, of course, various operating systems, such as an EMV (Europay, MasterCard, Visa) or German Eurocheque-compatible operating system.

The MIFARE®1 Plus Smart Card Chip will be based on a 8051 microprocessor core. The chip will be available at Mikron/Philips Semiconductors by the end of 1996.

Please see below the principals of the technical concept of this new innovative Smart Card Chip.



Picture 3: Technical Concept MIFARE® Plus Card

4.2 Applications

The target application of the MIFARE®1 Plus Card is banking. Thanks to the fast contactless MIFARE® interface, application providers can run reliable systems, while convenience is offered to the Smart Card user. The additional plus is that the same Smart Card can be operated within the existing contact infrastructure (Telephones, POS Terminals, ATMs) as well as with any MIFARE® terminal.

The MIFARE®1 Plus card allows to combine payment in existing applications like the Eurocheck electronic purse and convenient payment of fares in automatic fare collection system with a single card. Therefore, MIFARE®1 Plus is the ideal Smart Card to get banks involved in public transport applications and offer for the first time a single card for all applications within a community to the user.

5 New market segments for Contactless Smart Cards

The first Contactless Smart Cards fulfilling the requirements of credit card size (and thickness) as defined in ISO 7816-1 and ISO 10536-1 respectively, as well as the requirements for ISO bending and torsion test were launched at the beginning of 1995 using MIFARE® technology from Mikron/Philips Semiconductors. Since then they have been extensively trailed worldwide in more than 20 pilots and installations, like Sydney, Ajax, Burlington, Frydek Mistek, Liverpool, Huddersfield, Oslo, Helsinki, Pori, Tarn, Valance, Lüneburg, Esslingen, Seoul, Penang and Lufthasa to mention only some of those.

The advantages of Contactless Smart Cards in public transportation project are obvious. Beside one of the major projects in public transport (Seoul Bus Union) I have also chosen two other different applications where MIFARE® Contactless Smart Cards are used.

5.1 Public Transport System in Seoul Korea

Participants:

Service Provider:
Seoul Bus Union

System Integrator / Manufacturer:
Intec Ltd. of Seoul / Korea

Chipcards:

Gemplus

Chip Card technology:

MIFARE®

Smart Card Technology Provider:

Mikron GmbH, a Philips Semiconductors Company

General Information about the project

Last October the Seoul Bus Union began a field trial to replace the traditional token payment with an electronic ticketing system using contactless smart cards in busses.

The new system was installed by Intec Ltd., a Korean company which started working in the field of contactless technology in May 1995, and had previously been operating a Korea-wide electronic purse based on magnetic stripe technology.

By the end of 1995, more than 200 busses were equipped with terminals accepting payment with Contactless Smart Cards, while already 20,000 cards were issued. After the successful completion of this trial, the Seoul Bus Union decided to roll out electronic ticketing on a large scale, and assigned the task of system installation in all 8,725 busses to Intec by the end of June 1996. This ambitious time schedule was kept and by the end of August 1996 Intec expect to have 1 million MIFARE® Cards distributed to the public.

Having completed the installation in Seoul successfully Intec signed a contract to equipp further 4300 busses of the Kyungki Bus Union (metropolitan area of Seoul) with MIFARE® terminals within 1996. Further plans are to extend the system to Seoul Subways and to other Korean cities. In addition, the card is intended to be used as a loyalty card for frequent bus travellers.

In Korea a total of 2 million cards will be issued until the end of 1996.

How does it work

Passengers using the new system present their smart card at a validator on the bus. The fare, which depends on the card type (adult, student, etc.), is deducted automatically. One card can also be used for paying the fare of the entire family or of friends. When the card value runs low, the card can be reloaded at specified newsagents. The bus companies also allow reduced fares for frequent bus travellers.

Terminals and Readers

- Bus Validator
- Recharger for contactless and contact smart cards
- Card Issuing Machine

Selection of Partners

The technology provider and system integrator were selected according to the following characteristics:

Technology Provider:

- Proven technology
- Ability to support customer needs and to follow up market trends
- Continuous research and improvements

System integrator:

- Proven and business-related experience, especially in networking and clearing for settlement
- Successful operation of the system during the initial pilot phase from October to December 1995.

Preparedness of the end user

First of all, not only the end user and the bus companies were trained but also everybody else involved like passengers, employees at recharge stations and government officers. Of course, it is not trivial to develop a suitable system for automatic fare collection, to manufacture the required hardware and set up the network. According to Intec, training and operating, however, takes time and is one of the keys to a successful project. As service providers are not likely to take the risk of launching the system, Intec had submitted the following proposal which the service provider accepted: Intec conducts the test phase at its own expense and upon approval of the system by the service provider, Intec supplies the entire system without any initial payment. After the installation Intec will receive a revenue from each transaction on the bus cards. As mentioned before, Intec now supplies the entire system and the installation is completed, with 8,700 busses in Seoul.

The Solution

type of tag:	card
size:	ISO credit card-sized
memory of card:	8 kBit
average distance from reader to card =	5 to 10cm

Cards: at present 600,000 cards in use (as of June 30th),
within this year 2 million will be issued

Bus validators: at present 8700
within this year 10,000 bus validators will be installed

Initial Challenges

The main challenge during the realization of the project was the complexity of the whole automatic fare collection system consisting of several hardware and software components. Intec's approach to the required solution was to develop the network and the software first, and in a second step to design the required hardware (validators, etc.). Another critical issue is reliability. The fact that Intec has to compensate the bus companies involved for any loss resulting from a failure of the system stresses the importance of reliability.

General Benefits

- Reduced cash and token handling, and token issue
- Faster transaction speeds, less 'fumbling for coins and tokens' and reduction of queues
- Enhanced card and system security with less fraud and theft
- Robust, sealed cards, readers & terminals ideal for hostile environments
- Secure and reliable data collection
- Marketing opportunities and improved customer interface
- Incentive rewards for frequent use rather than discounts

<u>The specific benefits for public transport are:</u>

- Reduced token and maintenance costs
- High throughput due to convenient handling of contactless smart cards

<u>Benefits for card issuers</u>

- Reduced cost of card issue and management
- Co-branding and joint marketing programs

<u>Consumer Benefits</u>

- Convenience of one card to replace coins, notes, tokens and in the future, also other cards
- Quick and easy to use contactless smart cards which do not even have to be taken out of the wallet

- Bonus for frequent bus travellers
- Anonymity

Revenues

Intec receives revenues from each transaction done with a card for 5 years.

Analysis and Summary

The Seoul Bus Union is on its way to becoming the first major transport company in the world operating a fully integrated ticketing system based on contactless smart cards on a large scale.

The success of this field trial, which lasted till the end of 1995 and the very fast rollout of the system to all Seoul busses caused enormous interest for contactless smart cards in the Korean market. After an announcement by Mr. Cho Soon, Mayor of Seoul City, requesting that the subway should have a ticketing system which is compatible with the one of the bus union, first operational tests in Seoul Subways started in April 1996.

The future plan is to establish a compatible system for Seoul Subways, taxis and parking lots. In the long run Intec intends to extend the system to electronic purse functions for retail and banking applications.

5.2 Contactless Smart Cards in Road Toll

Thanks to its high speed and its multifunctional feature and versatility MIFARE® can also be employed for road toll systems. In July 1995 the French company GEA started a field trial for a MIFARE®-integrated touch-and-go motorcycle toll system in Penang Bridge Toll Plaza in Malaysia. Within the scope of the Launching Ceremony on October 28th, 1995, one lane, equipped with this system, was opened to the public.

The 10,000 prepaid and rechargeable cards issued where highly accepted by the motorists, and the system is already extended to all other motorcycle lanes in Penang Bridge. Also other additional installation of MIFARE® Contactless Smart Cards for Road Toll in Malaysia have already been started, like the installation on the Shan Alam Express Way.

The entire transaction for each vehicle including card transaction and gate operation does not take more than 3 seconds. Thus, thanks to the high transaction speed of the system installed, up to 1000 vehicles can be handled within one hour.

Bennefits of Contactless Smart Cards in Road Toll:

- Works relaiable in harsh enviroment with lot of dust, high humidity and rain
- No mantanance
- Automation of toll collection, replacement of manual toll collection

5.3 Contactless Smart Cards as Campus Card

Participants:

Service Provider:
Fachhochschule Esslingen, Germany

System Integrator / Manufacturer:
Cytec Cassen&Computer GmbH, Alsdorf Germany

Chipcards:
DataColor

Chip Card technology:
MIFARE®

Smart Card Technology Provider:
Mikron GmbH, a Philips Semiconductors Company

General Information about the project

Beginning of 1996 Fachhochschule in Esslingen started the project to introduce a multifunctional student ID Card covering different areas of the University like access control to laboratories, parking lots, canteen payment, etc.. Actually the installation of the hardware is close to be finished and the project will very soon go into full operation.

To make the expiration date of the card visible on the card surface there is an additional feature to the personalization on the card: a "write and erase" thermocromic layer laminated on the card surface.

The Fachhochschule Esslingen has about 6000 students studing in the average 4 years. With the Smart Card system also the access control and time management for employees are also done more efficiently than earlier.

How does it work

The primary application is the payment for services at the campus. Students are able to pay with their ID card for the following services:

- canteen and coffee shop
- copies
- parking
- purchase of books, brochures, student guide etc.
- payment of student fees

Terminals and Readers

- Central Terminal with Card Printer to issue Cards
- POS Terminal installed at copy machines, canteen, bookstore etc.
- Access Control Read/write device to open door to restricted areas
- Access Control Read/write device with time management function for employees
- Information Terminal to print out certificates and reports for students

Initial Challenges

The opportunity arising from the usage of Smart Cards supporting multiapplication functions have to be maintained over a long term period. This can only be achieved by a modular system enabling the university to add or replace several system features. According to Cytec the set up and the realization of such a modular concept has been the main challenge of this project. Another critical issue was the visible expiration date on the Smart Card. Selecting the right contactless technology, which can work together with the metal surface of the thermocromic layer, was quite a challenge. With MIFARE® a reliable technology was found to meet this requirement (which was important for the automatization of the registration process twice a year).

General Benefits

- Reduced cash handling
- Faster transaction speeds, less 'fumbling for coins' and reduction of queues (e.g. canteen)
- Enhanced card and system security with less fraud and theft, no more cash handling
- Robust, sealed cards, readers & terminals ideal for hostile environments like universities
- Secure and reliable data collection

Benefits for card issuers

- Reduced cost of card issue and management
- Statistic Data about use of laboratories, libraries etc.
- Automatic bookkeeping

Consumer Benefits

- Convenience of one card to replace keys, cash, and in the future, other cards too
- Quick and easy to use Contactless Smart Cards which do not even have to be taken out of the wallet

Analysis and Summary

The Fachhochschule Esslingen is on its way to fully automate the administration. After starting the use only at a part of the university the Fachhochschule will go further with a complete installation.

6 Conclusion

In conclusion, the requirements of all transportation applications can be ideally matched with Contactless Smart Cards. However, the use of contactless technology, offering a new combination of Contact and Contactless Smart Card capabilities in a single chip card is unlimited and will be a major step forward to a successful future of Smart Card technology in our daily life. Products, such as MIFARE® and MIFARE® 1 Plus, which are able to meet the demands of the market, are ready-to-use and technologically mature, while secure delivery is ensured by multiple sourcing. Due to the fact that representatives of several sectors have recognized the advantages of the contactless technology and are ordering it in high volume, the way for the use of contactless technology is paved for many different applications.

The Combination Smart Cards like MIFARE® 1 Plus will start the transition from Contact Smart Card to Contactless Smart Cards, having the capability to use the existing Contact Smart Card infrastructure and offering the additional advantages of the contactless technology (fast, no maintenance etc.) in a single Smart Card.

Thus, in the near future we expect a massive expansion of the use of Contactless Smart Cards and Combination Smart Cards.

ELECTRONIC PAYMENT SYSTEMS IN PUBLIC TRANSIT **

Michael Dinning
U.S. Department of Transportation
Cambridge, MA

John Collura
University of Massachusetts
Amherst, MA

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ABSTRACT

Many public transit operators in the United States are planning integrated, automatic fare collection systems (AFC). Like automated toll collection systems, AFC systems in public transit are part of the family of electronic payment systems envisioned in the Intelligent Transportation System architecture. An integrated AFC system typically uses advanced technology (e.g. magnetic stripe or smart cards) to collect fare payments electronically on two or more transit related modes (e.g. bus, rail, parking). Integrated AFC systems can result in many types of benefits for passengers and transit operators, including increases in revenue, reductions in operating expenses, and enhancements in security, equity, and quality of transit service.

The objectives of this paper are threefold: 1) to briefly review several initiatives underway in the U.S. to design and implement integrated, automatic fare collection systems 2) to examine the motivational factors and projected benefits which have provided the impetus for these AFC initiatives; and, 3) to identify and discuss the institutional and organizational issues associated with the implementation of integrated payment systems in the U.S., and the strategies employed to resolve these issues.

The issues faced by transit operators planning or implementing automatic fare collection systems include questions of: strategic planning and fare policy, technology, the payment settlement process, partnering agreements and governance, user acceptance and privacy

INTRODUCTION

While many issues have been addressed over the last several years regarding the technical feasibility and design of automatic fare collection (AFC) systems in public transit, a number of institutional issues and questions remain unresolved, particularly regarding the actual implementation of AFC systems in the U.S. Moreover, these unresolved issues can become very complex when AFC systems are integrated among various public and private modes such as commuter rail, express and local bus, rapid rail transit, and parking services. To assist the U.S. public transit community in the planning, design and implementation of integrated AFC systems, this paper focuses on the following questions:

- What types of AFC systems are being designed and implemented in the U.S.?
- What are the motivational factors and expected benefits prompting U.S. transit officials to employ integrated AFC systems?
- What AFC implementation issues have been encountered to date in the U.S., and how are these issues being resolved?

For example, if the fare collection systems of various operators or modes are integrated, how will the revenue reconciliation, or payment settlement, process be carried out, and what will be the roles and responsibilities of the public and private organizations involved?

This paper addresses these types of questions based in part on AFC case studies conducted in six major U.S. metropolitan areas. The six areas studied here include: Boston, Chicago, New York, San Francisco, Seattle, and Washington, D.C. Some additional information is also included in the paper from other cities involved in innovative AFC programs, including Atlanta, Ventura County, CA and Phoenix.

AFC TECHNOLOGY

These initiatives all include some form of AFC, or automatic fare collection system, incorporating a fare payment card with either a magnetic stripe, or integrated circuit chip for data storage. "Chip cards", or smart cards, may have either an electronic memory, or an integrated circuit capable of data processing. Planners in all six cases are considering a stored value card, where the equivalent of cash is loaded into the card's memory. Cards which debit or credit a traveler's account may also be used in AFC systems. These initiatives also involve fare integration, where the same fare media is used for the collection of payment on two or more operators and/or modes.

Based on these six case studies, it appears that the implementation of AFC systems usually follows an evolutionary process. Transit operators often begin to automate fare collection with the use of time based, read-only tickets (or magnetic stripe cards). They may then go to an enhanced magnetic stripe technology with read and write capabilities, which enable value to be stored, and later deducted from the card. These cards also facilitate the collection of distance based fares and transfers. A subsequent degree of technical sophistication is employed with smart cards. Smart cards have more powerful and flexible data processing and security features, enabling the use of larger amounts of stored value, more diverse fare programs and transfer schemes among modes, and the potential for other non-fare payment applications. The specific choice of technology varies among transit agencies, but some evolution of technology has occurred at each site studied.

TRANSIT SYSTEM INITIATIVES

After using read/write magnetic stripe cards for 20 years, the Washington Metropolitan Area Transit Authority (WMATA) is now testing a contactless smart card, called the Go Card. The added functionality of this card facilitates the application of the same card to rapid rail transit, busses and park and ride lots. The transit fares are distance based, are discounted for special segments of the population and vary by time of day. WMATA chose a contactless smart card to facilitate fare payments by the physically challenged and to increase station and turnstile throughput.

Another metropolitan area with experience using both magnetic stripe and smart card technology is Chicago. An integrated fare program using plastic magnetic stripe cards is now being implemented on rapid rail, bus and commuter rail systems. The Chicago Transit Authority (CTA) will act as the revenue clearinghouse for this multi-modal arrangement. CTA is also using contactless smart cards for employee access to maintenance facilities and fare boxes. In addition, the Regional Transit Authority (RTA) has tested contact smart cards, which are swiped through a reader onboard para-transit vehicles. An intended purpose of the RTA smart card is to facilitate the payment of distance based fares, through third party contracts with human service agencies whose clients use the RTA door-to-door paratransit services.

In New York, the Transit Authority has implemented their magnetic stripe, "Metro Card" on all buses, and is in the process of installing card readers at all rail transit stations. New York engineers are now testing various types of smart cards on the system, including both contact and contactless cards. In New York, the automatic fare collection system is being considered for application on many modes of transportation, and for small non-transportation purchases.

In addition, a the MTA Card Company, a subsidiary of the MTA, is developing a partnership with a financial institution to promote stored value cards in the New York area. This partnership would take advantage of the marketing, payment settlement and data processing infrastructure already developed by the financial industry.

The Metropolitan Atlanta Rapid Transit Authority (MARTA) is working with financial institutions to introduce stored value cards for the 1996 Summer Olympics. Visa and three banks will introduce the VisaCash stored value card, for payment of rapid transit fares, purchase of goods and services, and pay telephones. The VisaCash Card is a contact card, which meets the "standard" agreed upon by Visa, Mastercard and Europay. This card requires the patron to insert the card into a reader, involving physical contact between the card and reader. MARTA has installed secure communications to carry transaction data from the readers at station turnstiles to the financial institutions.

In addition, MARTA has introduced special magnetic stripe, time-based passes for the Olympic year. Each month, a different athlete will be featured on these multi-colored passes, and MARTA expects that many cards will be purchased by collectors.

The Phoenix transit system also uses magnetic stripe cards for payment of bus fares. Passengers may use credit cards in addition to transit fare cards in the bus card readers. At the end of each week, the credit card transactions are forwarded for processing.

In San Francisco, the Bay Area Rapid Transit District (BART) has had a magnetic strip card system since the system opened in 1972. BART has a distance-based fare system, and prints the patron's remaining value on their paper stored-value cards. BART recently joined the Contra Costa County Bus Company and the Metropolitan Transportation Commission (MTC) to demonstrate a multi-modal magnetic stripe card. The "Translink" card was used on both buses and rail transit, and the MTC is now working with operators to apply the integrated fare media concept throughout the region.

In Ventura County, California, contactless smart cards are being demonstrated on all the buses and paratransit vans of five different operators. In addition, many of these vehicles will be equipped with automatic vehicle location systems, and an automated dispatching system. By integrating automatic fare collection systems with other "Smart Bus" technology, these operators will reap several important benefits. The combined system will generate a wealth of data on ridership, useful for planning and marketing, as well as for the Section 15 reporting required by the Federal Transit Administration. Marrying this data with the automated dispatching system could also enable operators to optimize service and revenues.

DRIVERS & POTENTIAL BENEFITS

Many different motivational factors or "drivers" provide the impetus behind the initiation of an innovative AFC system. Often these factors are linked with the potential benefits of AFC systems. Some potential benefits may have financial implications in terms of increasing revenue or reducing operating expenses, while other benefits may have safety, equity, quality of service, and other positive implications. Examples of such motivational factors and their intended benefits are discussed below.

Enhance Passenger Convenience

Virtually all transit authorities claim that a primary reason they are considering fare integration and AFC technology is to enhance passenger convenience. Passenger focus groups in several cities have revealed a strong preference for using a single fare instrument, and eliminating the need to stand in long lines on a regular basis to purchase existing fare media. In addition, most operators believe that AFC technology, particularly contactless smart cards, will increase turnstile throughput, as shown in the Washington, D.C. Go Card demonstration. The contactless card has particular advantages for the elderly and physically challenged, because no direct contact with a card reader is required.

Improve Security

Transit officials in most cities agree that they forego thousands of dollars of revenue each year because of fare evasion, theft, counterfeiting and other forms of fare abuse associated with existing fare collection systems. Enhanced magnetic stripe technology and smart cards are being viewed as a way to reduce fraud and theft, and increase passenger safety. According to New York officials, implementation of magnetic stripe cards, new turnstile designs and increased police presence have reduced fare evasion by 50 percent.

Standards are being developed for smart card encryption which will greatly increase their resistance to counterfeiting.

Stored value cards which are issued with a unique identification number have the added advantage to the passenger that they can be invalidated if lost or stolen, and the passenger reimbursed.

Create New Revenue Sources

Some planners feel that implementation of automatic fare collection systems will increase ridership. A market study in Chicago estimated that trip making would increase 2 to 5% with the introduction of an electronic fare card. Another significant revenue source associated with prepaid stored value AFC systems is the interest earned on the cash collected. In addition, there is evidence that a percentage of the stored value on cards is never used. Other potential revenue sources with AFC systems may include purchases of illustrated cards by collectors, and advertising sales.

The New York City MTA Metro Card Company are taking the revenue generation concept one step further. The Card Company envisions selling the pre-paid card service to other organizations, such as schools, or possibly even to transit organizations in other major metropolitan areas.

Reduce Handling of Existing Fare Media

The handling of existing fare media, including tokens, paper transfers, and tickets, is very labor intensive and expensive. Planners in several cities, including New York, Seattle and Atlanta, have estimated that the use of AFC will reduce operating costs significantly. Automatic fare collection systems enable operators to reduce resources used to produce, distribute and administer cash and paper-based systems. Planners in Atlanta feel that the Visa Cash open system card will reduce the amount of cash and token handling resulting from single ride customers. This is their most costly type of revenue collection, and not a market penetrated easily by a transit-only stored value card.

Replace Unreliable, Out-dated Equipment

At several authorities, turnstiles in rapid transit stations and fare boxes on buses need to be replaced because such equipment has reached the end of its "useful" life, and is experiencing unacceptable failure rates and high maintenance costs. In fact, the need to replace existing equipment has been a major factor which prompted transit officials in Boston (MBTA), New York (MTA), and Chicago (CTA) to consider examining the use of more efficient and effective methods to process fare payments. Reliability of the new magnetic stripe system in New York, and both the magnetic stripe and smart card systems in Washington has been extremely good, according to local transit officials.

Implement Integrated Fare Policies

A major aim of the six metropolitan transit authorities studied is to establish integrated fare policies which are equitable to patrons, and encourage ridership and coordination among transportation operators. For example, read/write cards can facilitate the use of distance based fares, which are more directly related to the costs incurred to provide service.

Furthermore, regional transit authorities in Seattle, Chicago and San Francisco have stated that public and private transit operators are more inclined to coordinate their fare collection methods if the automatic fare collection system can ensure that revenues are apportioned according to actual service provided.

Smart cards will provide additional flexibility, and enable use of a variety of fares. The Central Puget Sound Fare Integration planners project that a smart card system will facilitate more cost-effective expansion of incentive programs with employers, by streamlining the process of distributing and administering fare media.

A long term goal in all six metropolitan areas studied is to encourage transit operators to coordinate their fare policy, and indeed, their operations. Such coordination may facilitate the establishment of an intermodal system, consistent with federal, state and local transportation objectives. At the same time, however, smart cards will enable individual operators to retain their own fare structures, if desired.

Facilitate Decisionmaking and Auditing

A significant benefit of an AFC system is that it generates very detailed data on ridership, as described previously for the Ventura County SmartCard Project. This information is valuable to planners and management for several reasons: 1) it assists transit planners in collecting ridership data and in forecasting travel demand, in the design of new services, in the evaluation of alternative fare structures and in marketing; 2) it facilitates overall decisionmaking and aids management in making investment decisions; and 3) it improves the process for auditing service provided, so that operators, employers, human service agencies, and other third parties are more inclined to engage in "purchase of service contracts", transitchek programs, and other agreements to transport their employees/clients.

PLANNING & IMPLEMENTATION ISSUES

Based on the experiences in the six case study areas, a number of issues have been identified related to the planning and implementation of integrated AFC systems. These issues center around: 1) strategic planning and fare policy, 2) technology considerations, 3) the payment process, 4) partnering agreements and governance, 5) user acceptance, and 6) privacy.

Strategic Planning and Fare Policy

One problem encountered at several transit authorities is that the AFC system was originally viewed by some as a "technology solution looking for a problem". The Translink Project in San Francisco revealed that the most difficult issues facing a fare integration effort are not technical, but institutional. As described in this paper, automatic fare collection systems can help streamline operations and reduce operating costs. Most transit operators have found that a comprehensive plan, and "Business Case" for implementation is needed. This plan should identify future business processes and organizational changes needed to get the most out of new automatic fare collection technology.

Planners in Seattle, San Francisco and New York have emphasized that a critical step in the strategic planning process is the definition of AFC system objectives. These objectives should align the AFC capabilities with transit system and regional transportation goals. Furthermore, the AFC objectives provide the basis for the development of an overall evaluation plan and the identification of appropriate, quantitative and qualitative evaluation criteria. These criteria are used to assess the extent to which AFC objectives have been achieved during demonstrations and incremental implementation.

Planning partners in several regions have found that fare policy is one of the most sensitive issues to be resolved. The degree to which operators maintain their fare-setting autonomy and their own distinct market identity should be addressed. Planners have also found that fare integration projects can lead to consideration of inter-agency and intermodal service coordination to maximize productivity and ridership.

Another critical part of the strategic planning process is development of a "Business Case" for the AFC project. The Business Case will provide a strategic plan for how the AFC technology will be implemented, and how it will affect business processes. The Business Case should estimate the capital and operating costs, and project economic, operational and other benefits. The costs and benefits accruing to each participant in the integrated AFC project must be projected. Planners in Seattle and New York City have found that the Business Case is critical: in determining overall feasibility, in formulating a financing scheme and in obtaining management and political support for the project. Experience in the U.S. to date indicates that transit technology managers are often unfamiliar with this type of planning, and that the data required for the Business Case may be difficult to obtain. Benchmark data, such as market acceptance of smart cards, may have to be generated from customer focus groups, or collected from initiatives outside the U.S., or from non-transportation applications of similar technology.

Strategic planning for fare integration should also address the potential changes to business processes, and organizational roles and responsibilities. The changes in operational, financial and information management processes must all be considered. Planners in New York, San Francisco and Seattle are exploring regional consolidation and streamlining of processes, such as: marketing, distribution and sales of fare media, payment settlement and overall revenue administration, and information management.

Another critical part of planning concerns the scale and scheduling of actual field implementation. Some systems, such as Washington, D.C., New York City and Boston, have initiated implementation gradually on selected modes, routes and stations as opposed to trying to implement the AFC system on all routes and on all modes at one time. Smaller scale field demonstrations are a tactic being used by Seattle Metro and several other authorities to introduce AFC, and to refine system designs in an evolutionary manner. Planners in New York and Washington have found, however, that a critical mass of the system may need to be involved in demonstrations to fully appreciate impacts and benefits, particularly those related to intermodal operations.

Implementation of an open system, such as the VisaCash initiative in Atlanta, requires involvement by a significant percentage of merchants and service providers. In Atlanta, the Olympic Games has provided the impetus for widespread implementation of the smart card system to thousands of merchants in a very short period of time.

A factor considered in the selection of appropriate stations for initial implementation has been equipment installation. For example, in some rapid transit stations in New York City, there is much more space in which to install new equipment than in other locations; this new equipment would be installed first and used while the existing equipment is being retrofitted. In addition, New York has found that retrofitting old equipment may require significant infrastructure modifications, such as power upgrades.

Technology

A major issue in AFC system planning focuses on what AFC technology should be used. For example, if it has been determined based on a review of the AFC objectives that a stored value system is desired, will a magnetic stripe card be adequate or are the additional features of smart card applications essential? If a smart card is essential, should it be of the contact or contactless type?

New York City MTA transit officials have learned that stored value magnetic stripe cards work effectively on their rapid transit system, and expect to reduce operating expenses associated with the handling and sale of conventional fare media such as tokens. However, MTA officials also recognize that there might also be other positive financial implications with smart card technology in terms of generating new revenue sources as described previously. The fact that the financial industry which the MTA Metro Card Company seeks to partner with is likely to adapt a contact smart card has led them to seriously consider the applicability of the contact card to transit.

Seattle and most other U.S. operators are considering contactless smart card technology because of its perceived advantages in convenience, throughput and maintenance costs. Seattle planners are designing an integrated AFC system using contactless cards on intercity rail, five bus systems, and the state ferry services.

Some equipment vendors expect that economical „combination" cards will be available in the near future, which are both contact and contactless. If combination cards are eventually put into widespread use, this would enable transit operators to get the operational benefits of contactless cards, yet also accept the cards issued by financial institutions.

The interoperability of card technology is also a concern. Visa, Mastercard and Europay have agreed on the so-called "EMV" standard for implementing contact cards, built on ISO technical standards. Similar ISO standards for contactless cards are developing, but the interoperability of various vendors' contactless card products is not assured at this time.

Magnetic stripe card applications have been used more extensively in public transit in the U.S. because it is a proven AFC technology in the U.S. transit industry. The CTA in

Chicago and the MBTA in Boston chose magnetic stripe technology for their initial upgrades to avoid the risks related to the use of untested smart card technology. Many transit operators feel that more demonstrations and benchmarking are needed to prove the acceptance and reliability of smart cards in the transit environment.

Transit operators would like future smart card technology to use an open system architecture, to allow interoperability and compatibility between different vendors' products, and facilitate migration to new technology as it evolves. These requirements must be strongly articulated to equipment suppliers to drive the market towards interoperable products. A joint equipment procurement by several operators might be used to increase their leverage. Planners in Atlanta feel that initial implementation of contact card technology may provide a more flexible platform for eventual inclusion of contactless cards on their system, as opposed to starting with non-standardized, contactless cards.

Payment Process

The payment process includes the sale and issuance of fare media, and payment settlement and reconciliation of revenues among service providers. The manner in which this process is conducted in the U.S. in connection with integrated AFC systems in public transit has varied administratively and organizationally. For example, in Washington, D.C., WMATA has administered the magnetic stripe card and smart card payment processes in-house, because their cards currently apply to operations totally under their control.

In San Francisco, the Metropolitan Transportation Commission has formed a "Clearinghouse Committee" to re-engineer and integrate the revenue management processes of the 23 operators in the Bay Area. Similarly, the Fare Integration Project in Seattle has formed a multi-operator planning group which, led by Seattle Metro, jointly develops regional fare integration plans.

The MTA in New York City, on the other hand, is already proceeding to form a partnership with a private financial institution, reported to be Chase Manhattan Bank. MTA officials plan to apply the stored value technology to several modes and possibly to non-transportation retail uses as well. MTA planners believe that an external clearinghouse would be more efficient and effective, and more appropriate for their revenue generation strategy. The recent proposals by banks and credit card companies for electronic purse services indicate that external partners may be available on a large scale in the future. Some transit managers have stated that partnering with an external organization for revenue management services would not only be more efficient, but would also allow the transit organization to focus more effectively on their primary mission of providing transportation services.

In financial institution lexicon, the present WMATA payment process is referred to as a "closed" system, and the payment process anticipated in New York City is considered an "open" system. In general, it appears that for AFC systems which involve only one service provider such the MBTA, a "closed" system may be deemed appropriate for the near term, and such a system might be administered in-house with relatively fewer changes in the internal organizational structure and accounting procedures. If the transit operators wish to leverage the infrastructure established by the financial industry, and implement a stored value fare card which is applied to several non-transportation uses, an "open system" with an external clearinghouse would probably be necessary to handle the payment settlement among the many service providers. As open system stored value cards become available in the U.S., the Business Case for transit/financial institution partnerships will become more attractive.

Partnering Agreements and Governance

If two or more transit operators or service providers are involved in an integrated automatic fare collection system, it is likely that some sort of written agreement will need to be established. In such agreements each transit providers, fare policies and structures would be described and the method of revenue apportionment would be defined. It should be noted here that in order to realize the full benefits of an AFC system, service providers and operators must agree to discuss the possibilities of coordinating their fare policies.

In addition, fare integration plans may require participants to create a new organization to plan and "govern" the arrangement. This organization should involve senior management to ensure commitment and participation. If third party contracts for service are anticipated with human service agencies, employers, or other organizations, written agreements should be designed concerning the method and basis of payment, and related accounting and auditing procedures.

If the payment process is of the "open" type and an external clearinghouse is involved, then the details of these agreements need to be incorporated in the clearinghouse's accounting and payment settlement procedures. An open system will involve public and private organizations from entirely different cultures (i.e. transportation and financial), so considerable planning and discussion will be required to develop a strategy which meets the interests of all participants. The partnership developed by the New York Metro Card Company may provide many lessons learned for other agencies, as will open system projects outside the United States.

User Acceptance

Users of integrated AFC systems include: passengers, bus drivers, service providers and operators, and third party contractors. While passengers may be attracted to AFC systems because they are more convenient, some "learning curve" and resistance will have to be overcome. To facilitate the use of the magnetic stripe cards in the critical phase of AFC implementation in Boston and New York City, transit officials demonstrated the use of the magnetic stripe card to passengers and answered questions in selected subway stations. In addition, passenger focus groups have been instrumental in planning automatic fare collection systems, and in resolving various human factors issues. In New York, this process identified many issues related to the use of their magnetic stripe card application, which in turn has assisted MTA in bringing about a steady increase in passenger acceptance and actual usage.

The Smart Card Forum, an industry group formed to promote this technology in many sectors, has conducted a study of user concerns with smart card technology. The major concerns of potential users (for all types of payment, not just transportation fares) were:

- Others could access information
- Others could use card for purchases
- If lost, card holder would lose money
- Doesn't protect privacy
- Private information on card
- Card holder wouldn't know value remaining
- Difficult to access information
- Card wouldn't be accepted
- Hassle to put money on
- Take more time than cash

Most of these concerns are being addressed in ongoing transit applications. Customer feedback in all areas studied has been generally very positive regarding electronic fare cards.

Bus operators are also "users" of AFC system. Operators monitor the use of the AFC system to ensure that a passenger has paid a fare. The vehicle operator must have a pre-planned procedure to deal with passengers whose cards are rejected. Such procedures might include the option of having the passenger pay the fare with the exact change or, as is the case in San Francisco or Washington, the passenger is given "the one last ride". What is important to emphasize is that unless a pre-planned procedure is established involving minimal operator intervention, confusion and significant delays may take place which may lead drivers to ignore such invalid and inappropriate card usage and consequently lead to a loss in revenue.

Other users of the AFC system include transit service operators and third party contractors, who must be convinced that such AFC systems have security features to guard against fraud, counterfeiting, fare evasion, and other forms of fare abuse.

Transit operators involved in fare integration strategies also need to know that revenue will be apportioned in a reliable and equitable manner. Operators who hire third party contractors want to be assured that their clients, trips are properly validated with generally-accepted accounting and auditing procedures.

Privacy

Many operators are planning to introduce rechargeable smart cards, which may have unique serial numbers. These cards have the advantage that they could be canceled if lost or stolen. Like debit and credit cards, however, smart cards with unique identification numbers will generate a record of transactions and travel that some users may feel is invasive if it can be associated with the traveler's identity. To allay these fears, some operators are considering giving customers a choice of whether they purchase "anonymous" cards, or cards with identification numbers. Some transportation legal specialists feel that use of the card on public transportation does not constitute a legal invasion of the rider's privacy, because they are using the card on a public conveyance.

While the legality of such issues is yet to be tested, it behooves operators considering the use of such technology to develop a privacy policy which clearly defines potential uses of information to the customer, and to the extent possible, maintains rider anonymity. Transit operators could also advocate for local legislation which would spell out the limits and controls for data collected and generated, and therefore, reassure users.

SUMMARY

A number of efforts are being made in major U.S. metropolitan areas to implement integrated automatic fare collection systems on public transit services including: rail, bus, ferry, and parking facilities. An underlying aim of an integrated payment system is to employ a fare collection medium (such as a stored value magnetic strip or smart card) which will be used by two or more service providers,

facilitate fare collection, and make the payment of fares more convenient and easier on the part of riders.

In addition, integrated payment systems make it easier to implement coordinated payment policies among service providers, which may facilitate transferring between services, lead to the adoption of more equitable fare policies and encourage ridership.

Other factors which often tend to be the major driving forces behind an automatic fare collection system effort are the potential to increase revenue and reduce operating expenses. It is anticipated that income may increase as a result of new revenue streams including: the interest earned on the cash received in the form of pre-payments, advertising sales, and purchases of cards by collectors. Operating expenses may also decrease because of reductions in equipment and labor costs related to: a) the sale and handling of token, tickets, transfers, and other conventional media, and b) the maintenance of obsolete turnstiles, fareboxes, and other existing fare collection equipment which have reached the end of their "useful life".

A significant additional benefit of an automatic fare collection system is its ability to capture ridership data and other information. This information is viewed by transit officials as extremely valuable in optimizing transit services, particularly during times of declining budgets.

In addition to reviewing the expected benefits and driving forces behind automatic fare collection services, this paper identified the major institutional and organizational issues encountered in payment system implementation. These issues center around: strategic planning concerns, technology considerations, the payment process, partnering, user acceptance, and privacy.

A major conclusion is that the design of an effective and acceptable integrated payment system requires a full understanding of the interests of all participating parties and stakeholders (public and private), and their expectations in terms of expected benefits and cost sharing. This understanding is essential so that negotiations among parties can take place in a productive and amicable manner, and that necessary written assignments between parties and stakeholder can be established. While it is recognized that individual service providers want to maintain a particular image and ridership loyalty, and certainly do not want to diminish current revenue levels, some fare policy coordination among operators and providers may need to take place to optimize overall benefits.

Moreover, banks and other financial institutions clearly see transit as a large potential market for stored value cards. Transit planners are beginning to explore whether partnerships with financial organizations can be constructed to provide a mutually acceptable "rate of return" for all parties.

In closing, it is clear that many U.S. transit operators are becoming convinced that automatic fare collection systems can provide many benefits and facilitate improved ways of doing business. Many operators are beginning an evolutionary implementation process by demonstrating magnetic stripe card or smart card technology, but continuous careful planning and development of new business processes and organizational relationships are needed. The Business Case for electronic payment systems must be developed for small and medium sized operators, as well as for the large regional groups of operators studied for this paper. Finally, implementation of integrated automatic fare collection systems will promote stronger partnerships among operators of all modes of transportation, and potentially with new partners in the financial community as well.

Reflections on Technology and Fare Collection for Public Transit

Steven E. Polzin, Ph.D., P.E.

Center for Urban Transportation Research
University of South Florida

Prepared for

Fare Technology Workshop
Florida International University

Sponsored by
Florida international University
National Urban Transit Institute

September 1996

Will Not:

- Report on operational tests of fare collection technology
- Espouse a given technology or capability
- Purport to be an expert on the integration of fare collection with APTS or other advanced MIS type systems.

Will:

- Offer some opinions on the relevance of fare collection to the success of public transit
- Comment on the relationship of fare collection to ongoing trends in the transit industry
- Discuss some of the issues relevant to making decisions regarding fare collection

Transit Fares

Fare Policy

- Farebox recovery ratio/revenue requirements
- Mode/quality of service/market differentiation
- Time of day/transfer/distance based differentiation
- Rider characteristics (age, disability, financial means)
- Advanced purchase/bulk purchase/pass purchase
- Policies on fare collection/enforcement/etc.

Fare Structure

- Determination of media, eligibility, distribution, price relationships, enforcement, etc

Fare Level

- Prices by media type

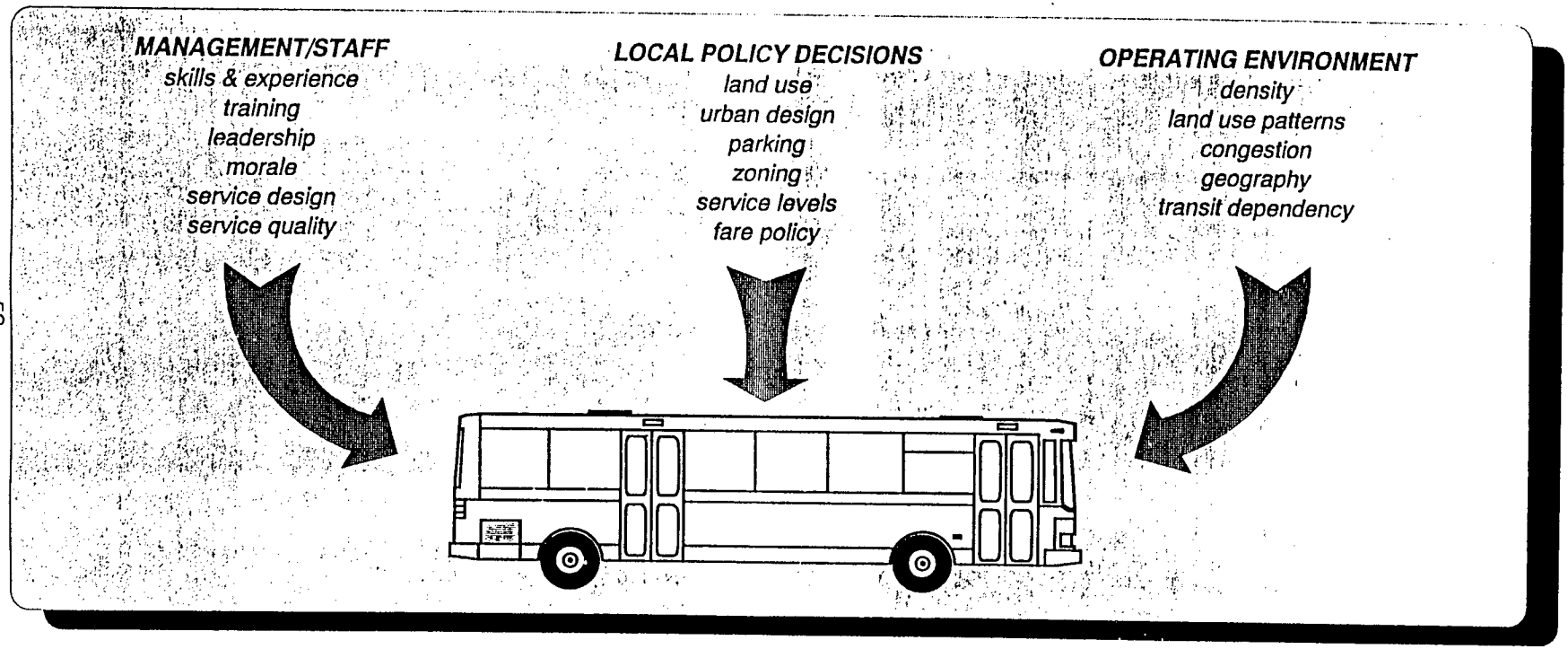
Two Principle Considerations

Impacts on Ridership/Public

Cost
Comprehension
Convenience
Safety

Impacts on Operator

Cost to purchase/administer/operate
Security
Flexibility
Revenue potential
Image
Other data opportunities

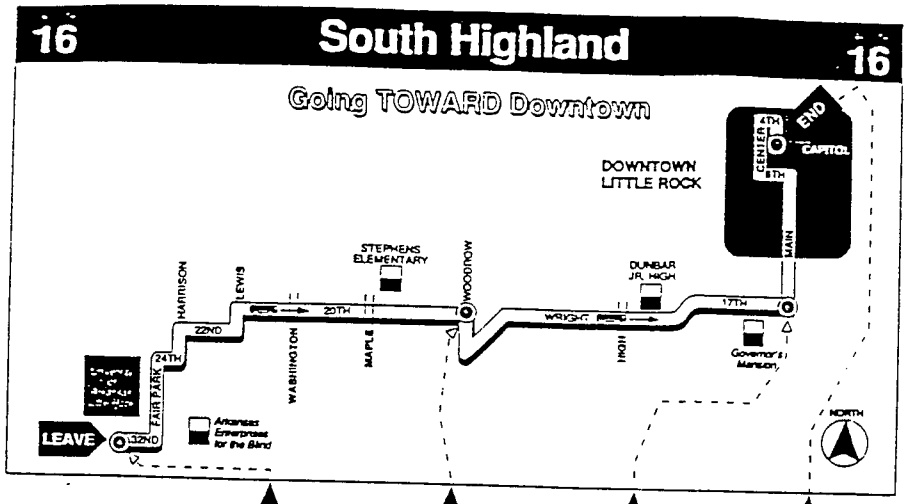

MANAGEMENT/STAFF
skills & experience
training
leadership
morale
service design
service quality
LOCAL POLICY DECISIONS
land use
urban design
parking
zoning
service levels
fare policy
OPERATING ENVIRONMENT
density
land use patterns
congestion
geography
transit dependency

Impact on Ridership/Public

Relationship between fares and ridership:

Cost	Elasticity = -.29 +/- .1 *f* (of service quality, rider characteristics, trip purpose, etc) Free fares doubles ridership? Sensitivity to out-of-pocket vs. Prepaid?
Comprehension	Transit Rider Profile Literacy in America
Convenience	Onerousness of fare payment time
Safety	?

Suppose that you took the 12:45 p.m. bus from U.A.L.R. Student Union to 17th and Main on a Saturday. According to the schedule, how many minutes is the bus ride?



		BUS LEAVES from U.A.L.R. Student Union	Bus arrives at 20th & Woodrow	Bus arrives at 17th & Main	BUS ENDS at Capitol & Louisiana
		WEEKDAYS			
A.M.	♿	5:38	5:51	6:00	6:09
	♿	6:11	6:25	6:35	6:45
	♿	6:41	6:55	7:05	7:15
	♿	7:11	7:25	7:35	7:45
	♿	7:41	7:55	8:05	8:15
	♿	8:11	8:25	8:35	8:45
	♿	8:41	8:55	9:05	9:15
	♿	9:14	9:27	9:36	9:45
	♿	9:44	9:57	10:06	10:15
	♿	10:14	10:27	10:36	10:45
	♿	10:44	10:57	11:06	11:15
	♿	11:14	11:27	11:36	11:45
P.M.	♿	11:44	11:57	12:06	12:15
	♿	12:14	12:27	12:36	12:45
	♿	12:44	12:57	1:06	1:15
	♿	1:14	1:27	1:36	1:45
	♿	1:44	1:57	2:06	2:15
	♿	2:14	2:27	2:36	2:45
	♿	2:44	2:57	3:06	3:15
	♿	3:14	3:27	3:36	3:45
	♿	3:43	3:56	4:05	4:15
	♿	4:13	4:26	4:35	4:45
	♿	4:43	4:56	5:05	5:15
	♿	5:13	5:26	5:35	5:45
	♿	5:45	5:58	6:07	6:17
	♿	6:11	6:22	6:30	–
	♿	6:46	6:57	7:05	–
		SATURDAY			
A.M.	♿	5:38	5:51	6:00	6:09
	♿	6:45	6:57	7:06	7:15
	♿	7:45	7:57	8:06	8:15
	♿	8:45	8:57	9:06	9:15
	♿	9:45	9:57	10:06	10:15
	♿	10:45	10:57	11:06	11:15
	♿	11:45	11:57	12:06	12:15
P.M.	♿	12:45	12:57	1:06	1:15
	♿	1:45	1:57	2:06	2:15
	♿	2:45	2:57	3:06	3:15
	♿	3:45	3:57	4:06	4:15
	♿	4:45	4:57	5:06	5:15
	♿	5:45	5:57	6:06	6:15
	♿	6:44	6:56	7:05	–

On Saturday afternoon, if you miss the 2:35 bus leaving Hancock and Buena Ventura going to Flintridge and Academy, how long will you have to wait for the next bus?

ROUTE **5**

VISTA GRANDE

This bus line operates Monday through Saturday providing "local" service to most neighborhoods in the northeast section.
Buses run thirty minutes apart during the morning and afternoon rush hours Monday through Friday.
Buses run one hour apart at all other times of day and Saturday.
No Sunday, holiday or night service.

OUTBOUND
from Terminal

	Leave Downtown Terminal	Leave Hancock and Buena Ventura	Leave Citadel	Leave Rustic Hills	Leave North Carefree and Oro Bianco	Arrive Flintridge and Academy
AM	6:20	6:35	6:45	6:50	7:03	7:15
	6:50	7:05	7:15	7:20	7:33	7:45
	7:20	7:35	7:45	7:50	8:03	8:15
	7:50	**8:05**	**8:15**	**8:20**	**8:33**	**8:45**
	8:20	8:35	8:45	8:50	9:03	9:15
	8:50	**9:05**	**9:15**	**9:20**	**9:33**	**9:45**
	9:20	9:35	9:45	9:50	10:03	10:15
	10:20	10:35	10:45	10:50	11:03	11:15
	11:20	11:35	11:45	11:50	12:03	12:15
PM	12:20	12:35	12:45	12:50	1:03	1:15
	1:20	1:35	1:45	1:50	2:03	2:15
	2:20	2:35	2:45	2:50	3:03	3:15
	2:50	**3:05**	**3:15**	**3:20**	**3:33**	**3:45**
	3:20	3:35	3:45	3:50	4:03	4:15
	3:50	**4:05**	**4:15**	**4:20**	**4:33**	**4:45**
	4:20	4:35	4:45	4:50	5:03	5:15
	4:50	**5:05**	**5:15**	**5:20**	**5:33**	**5:45**
	5:20	5:35	5:45	5:50	6:03	6:15
	5:50	**6:05**	**6:15**	**6:20**	**6:33**	**6:45**
	6:20	6:35	6:45	6:50	7:03	7:15

INBOUND
toward Terminal

Leave Flintridge and Academy	Leave North Carefree and Oro Bianco	Leave Rustic Hills	Leave Citadel	Leave Hancock and Buena Ventura	Arrive Downtown Terminal
6:15	6:27	6:42	6:47	6:57	7:15
6:45	**6:57**	**7:12**	**7:17**	**7:27**	**7:45** Monday through Friday only
7:15	7:27	7:42	7:47	7:57	8:15
7:45	**7:57**	**8:12**	**8:17**	**8:27**	**8:45** Monday through Friday only
8:15	8:27	8:42	8:47	8:57	9:15
8:45	**8:57**	**9:12**	**9:17**	**9:27**	**9:45** Monday through Friday only
9:15	9:27	9:42	9:47	9:57	10:15
9:45	**9:57**	**10:12**	**10:17**	**10:27**	**10:45** Monday through Friday only
10:15	10:27	10:42	10:47	10:57	11:15
11:15	11:27	11:42	11:47	11:57	12:15
12:15	12:27	12:42 p.m	12:47 p.m	12:57 p.m	1:15 p.m
1:15	1:27	1:42	1:47	1:57	2:15
2:15	2:27	2:42	2:47	2:57	3:15
3:15	3:27	3:42	3:47	3:57	4:15
3:45	**3:57**	**4:12**	**4:17**	**4:27**	**4:45** Monday through Friday only
4:15	4:27	4:42	4:47	4:57	5:15
4:45	**4:57**	**5:12**	**5:17**	**5:27**	**5:45** Monday through Friday only
5:15	5:27	5:42	5:47	5:57	6:15
5:45	**5:57**	**6:12**	**6:17**	**6:27**	**6:45** Monday through Friday only

You can transfer from this bus to another headed anywhere else in the city bus system.

- Monday through Friday only

Impacts on Operator

Cost to purchase/administer/operate

Security

Flexibility

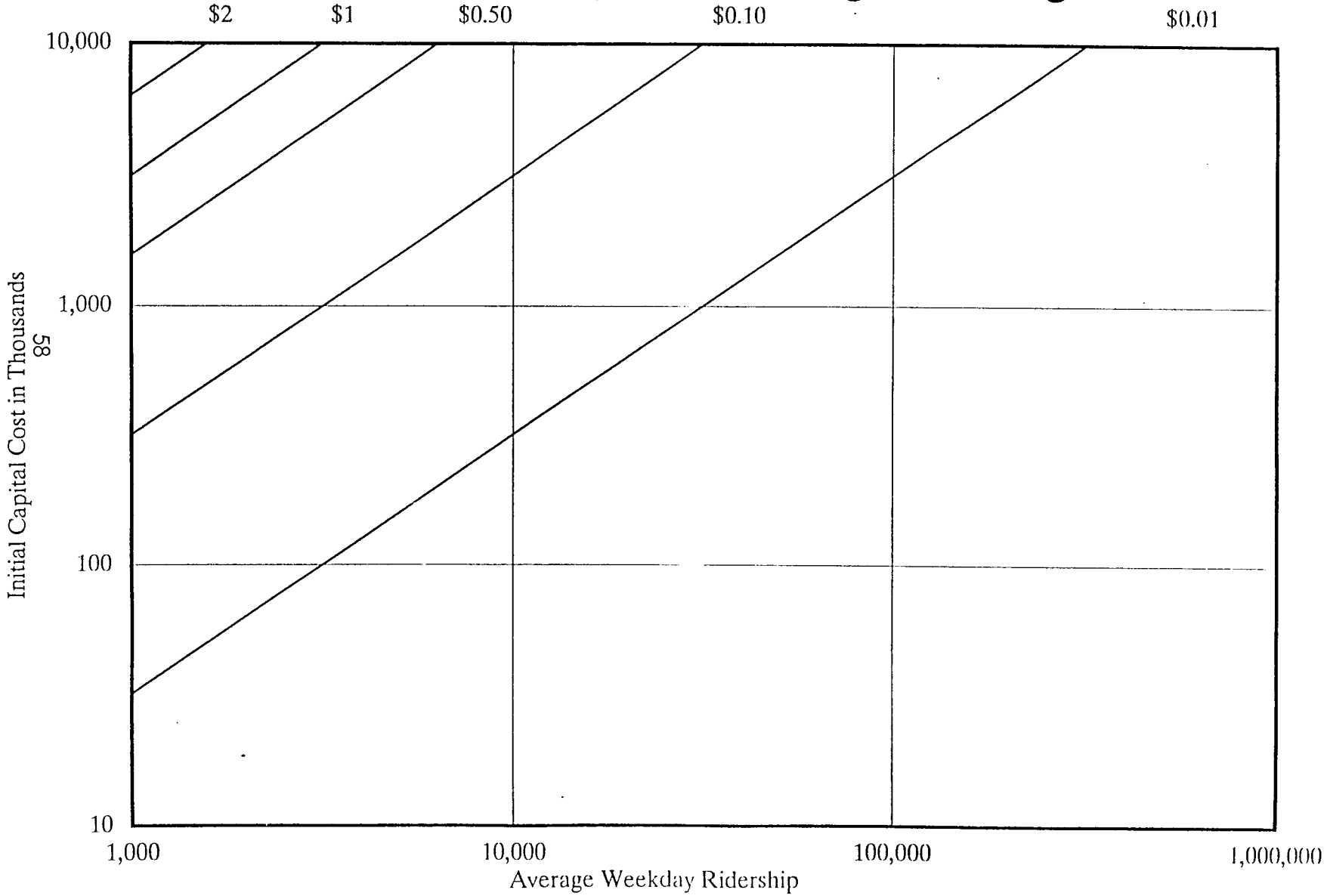
Revenue potential

Image

Other data opportunities

Uncertainty

Capital Cost per Boarding Passenger



Capital costs annualized over 20 years with 7% discount rate. Does not include operating/maintenance cost.

The Context for Fare System Evaluation

Money, money, money
- increase revenues
- reduce costs

The new age of intermodalism

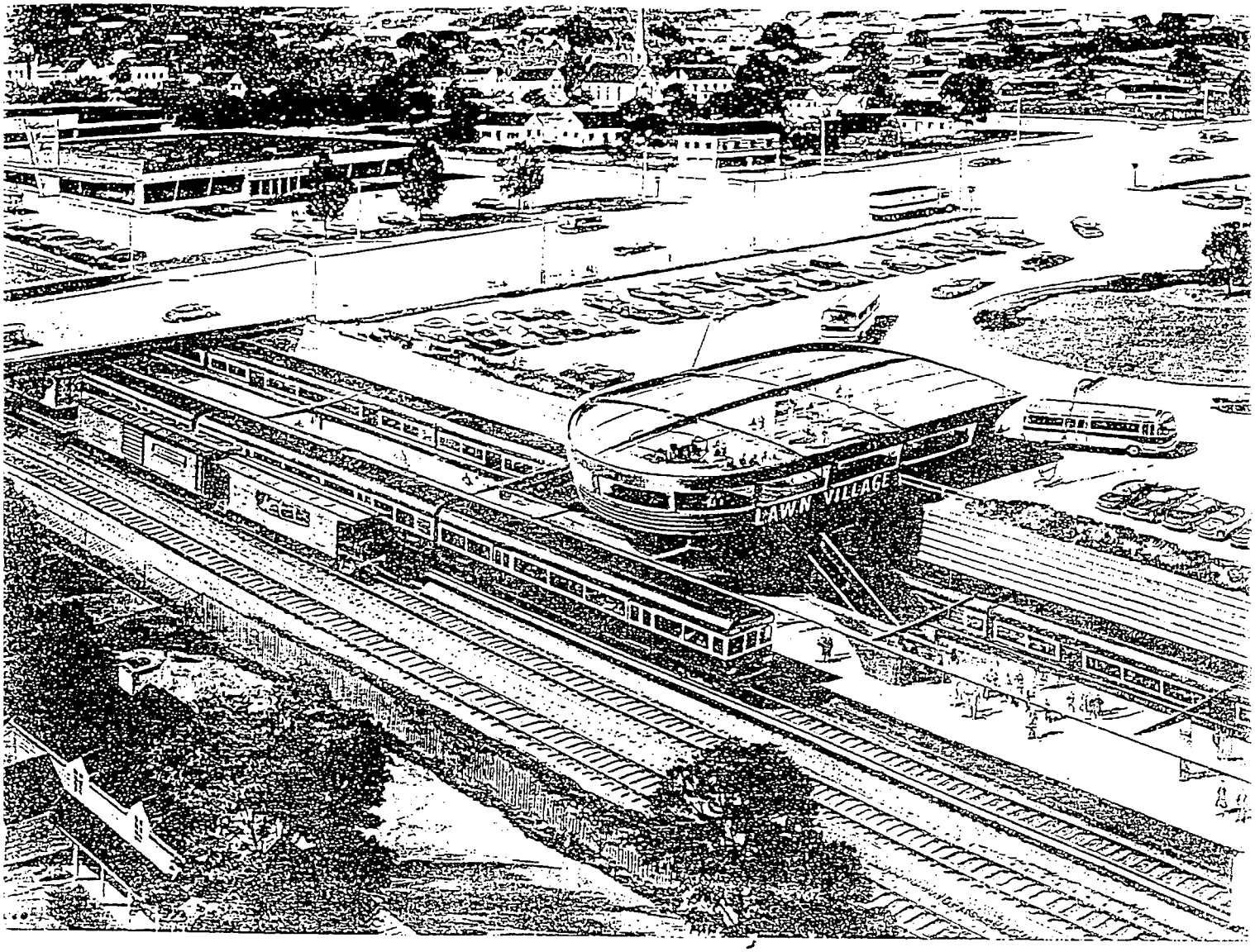
Extraordinarily rapid changes in
- technology
- institutional structure

High expectations from high tech

Focus on "level playing field", "balanced transportation system"

Transit land use relationships

More Goals
- Economic Development
- Community
- Livability/sustainability



COMMUTER SERVICE 1970?

For commuters in thousands of towns and villages that surround America's traffic-choked cities, travel in 1970 will be fast and convenient . . . if planning for coordinated metro transportation begins now.

SAVE MILLIONS

Improved and expanded commuter rail service is the key to better metropolitan transportation of the future. Millions of dollars will be saved if action is taken *now*. The rush-hour carrying capacity of one rail line is 20 times that of automobiles on an expressway lane—and there are no parking problems when the rail passengers arrive downtown!

Commuter rail travel in 1970 will be dynamically different from that of today. It will incorporate such advances as automatic train operation and fare collection, escalator movement of passengers and use of trains of light-weight, spacious commuter cars. Continuous through service from one side of a metropolitan area to the other, parking facilities adjacent to suburban rail stations, and feeder bus service to the station will provide new, high levels in rider convenience.

INTEGRATION NECESSARY

Before all of these improvements can come about, commuter rail and rapid transit operations must be integrated into a single, metropolitan-wide transportation system. Such integration will permit fast, flexible trains of transit cars to operate on rail facilities outside as well as inside the city. In addition to modernizing present commuter facilities, metro transportation networks of the future will use existing rail rights-of-way not now used for passenger service, at a fraction of the cost of building new rights-of-way.

NEW BROCHURE AVAILABLE

If you would like more information about modern metro transportation of the future, write for "Metropolitan U.S.A.—1970," Section 107-61A, General Electric Co., Schenectady, N. Y.

Progress Is Our Most Important Product

GENERAL ELECTRIC

A Pioneer is?

a.) A person who dreamed of a better day and was willing to take risks and invest energy and resources to attain that end.

b.) A person found lying face down in the dirt with the arrows of public criticism in his/her back.

If we can put a man on the moon then we can .....

"Implement a convenient, efficient and effective fare system"

The on-board navigational computer on Apollo 11 had

2K RAM

36K ROM

1 Megahertz operating speed

Introduction

myself

My name is Brian Doyle and I am the founder and President of Doyle Argosy Innovators Ltd. (DAI). We are the latest flavor to be served in the twenty billion dollar market feast of card technologies. Like the wedding in Cana, the magnetic card has been served, the guests have wet their lips on the glamorous chip card, and now we introduce the most practical capacitive card. Hopefully after having read this paper you will have acquired a taste for this brand new gender of card technology which we call CoinCard™. Aside from philosophical issues such as how widely distributed a distributed computing system should be (we believe that the intelligence should reside in the reader not in the card), our card systems have been conceived, designed and built with three paramount considerations; reliability, security, and low cost.

company

I had the good fortune of living and working for four years in Japan and recognized the convenience of pre-paid cards for telephones. DAI was founded upon my return to Canada in 1989 to develop and exploit the market for Stored Value Cards in North America. Initially the plan was to use magnetic systems but pre-marketing and early analysis indicated a lack of trust on the part of card issuers in magnetic card technology. Certainly in 1990 the potential market for chip card solutions for low value transactions appeared bleak given the cost of memory cards at that time. DAI took on a decidedly research and development character then, as we set out to develop a card technology which was both inexpensive and secure.

Given the recent almost total failure of magnetic cards from a fraud perspective, and the increasing cost of fabrication plants for microchip production, we remain convinced that our basic approach of providing an inexpensive yet secure card will win wide spread market acceptance. For example we are making inroads to the Pachinko market in Japan where magnetic cards have proven unsatisfactory and yet the shear number of cards issued, in excess of 250 million per month, mandates a very low cost card. DAI presently consists of a close knit group of 8 employees, capitalized at under two million dollars and working out of small lab space in Victoria, BC.

inventor

The basic concept for our card technology was invented by Dr. George May. Dr. May is the holder of over 40 international patents. His most significant previous invention was the world's first solid state digital telephone switching exchange manufactured by Harris Digital Telephone Systems Corporation with sales exceeding $500 million. DAI purchased the original patent from George and set out on our own to perfect capacitive cards.

Stored value cards

I will keep my comment brief for I trust your presence here confirms that you are one of the converted, or at least one who is in search of a better method of transacting small financial exchange. Coin, or small value transactions, present numerous unique problems to vendors

and manufacturers aside from the inconvenience and added cost of handling coinage. As an mundane example consider parking meters, our city of Victoria recently paid $60,000 dollars to retool 180 of their parking meters to accept the Canadian one dollar coins. In February the Bank of Canada issued a new larger $2.00 coin and once again the meter mechanism needs to be altered. A more serious problem is vandalism motivated by petty theifery. The city of Los Angles suffers up to 1.5 million dollars of damage a year to parking meters by individuals smashing meter heads to steal coin boxes.

Coin or low value transactions do have a positive flip side, however, in that they represent the largest untapped financial services market in the world. Stored value cards will play a prominent role in tapping this market. The market projections are astounding with projections for the year 2000 for yearly sales of 5.2 billion cards handling 55 billion transactions worth $20 billion dollars. Assuming a conservative 2% market penetration for our technology results in projected yearly sales of over 100,000,000 CoinCards per year! The one little tidbit from the study that I would like to leave you with, is " *according to Visa International's own consumer research, fully 24% of the respondents favored a stand alone disposable card*". CoinCards are the only cards which possess both security of transaction and low cost in one package, enabling the issuer to respond to this disposable preference. Usually you can have one or the other, but not both in the same card. Having both features simultaneously represents a major departure from earlier competitive technologies such as magnetic and chip memory cards. Certainly this technology represents one of the most innovative card technologies to emerge in some time. I can also state with confidence that Capacitive Stored Value cards, marketed under the trade name "CoinCards™", represent the least expensive non rechargeable memory card presently available.

cost

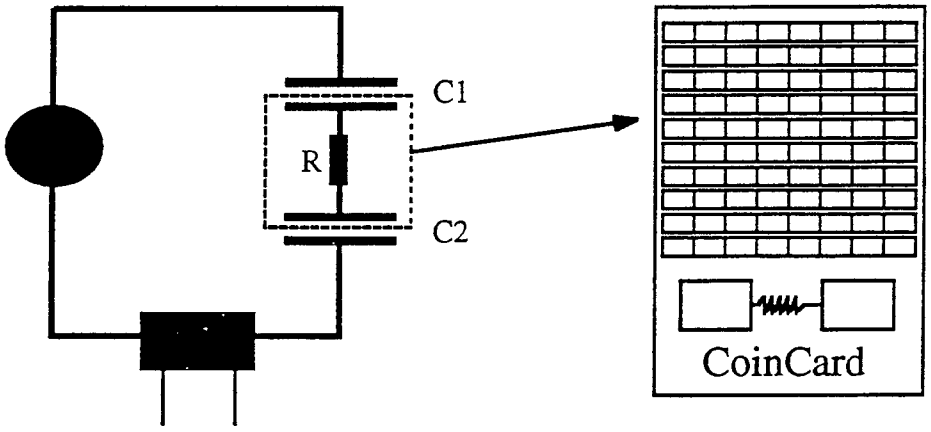
How inexpensive can CoinCards really be? The active component of a capacitive stored value card is a thin metalized polyester film. The processes for laminating and metalizing plastic films are well understood, very inexpensive, and widely practiced in the food packaging industry. The cost of this film is approximately 1/10 of a penny per card. This film, after being bonded to the substrate, is laser etched. The proprietary laser etching of a pattern costs another penny or two and takes mere seconds using advanced scanning technology. Since the card is designed to be disposable we presently use a more expensive polyester base resulting in the desired environmentally friendly (or recyclable) card. A totally finished, four color process, encoded machine readable polyester card sells for between ten and twenty cents. Paper card stock and more Spartan printing schemes are possible when a lower cost is desirable.

Technical description or principle of operation

CoinCards, as mentioned above, represent the least expensive memory cards in the world. Cards can be manufactured by the simple process of laminating a thin metalized polyester film to a thicker card substrate. The basic card with a sandwiched metallic layer is then etched or encoded using micro positioning laser markers. The reader/writer portion is a solid state hybrid ceramic circuit board. The two in combination represent a low cost, contactless, capacitively coupled, memory card system having the reliability and low energy consumption associated with no moving parts. In essence, a CoinCard is a robust PROM or bit addressable WORM memory.

Principle of Operation

Two Capacitors in Series becomes .... a Contactless Capacitive memory card



Hybrid Ceramic Sensor.....Inexpensive CoinCard

Consider the circuit diagram above showing two capacitors in series. The bottom plate of the top capacitor and the top plate of the lower capacitor along with the resistive fuse are reproduced on the card in the thin metallic layer. The remaining plates and the rest of the circuit including the inductive coil used to sense the flow of current through the fuse, are reproduced on the ceramic sensor. Both the sensor array and the data card include a plurality of primary and secondary electrodes having the same pattern. The data card further includes a plurality of fuses extending between each of the primary and secondary electrodes. When the fuse is intact, it will conduct current. When the fuse is blown, the resistance will increase substantially. The state of the fuse is used to represent binary bits of data. In operation, the card is juxtaposed with respect to the sensor array so that the respective electrodes at a given bit location can be capacitively coupled (Fig. 1). In order to read the card, an output having a predetermined voltage and frequency is applied to the electrodes. The level of AC current passing through the fuse is measured and the result is used to derive the state of the fuse. When information is to be written onto the card, the voltage level and the oscillating frequency are increased, causing current flow in the electrodes to increase thereby blowing the fuse. Current read/write systems are low in cost, low in power consumption, and have card memory densities of 128 bits. The ultimate bit density for a given card area is limited by the accuracy in positioning the data card with respect to the sensor array. Any misalignment between the card and the sensor with respect to electrodes reduces the efficiency of the capacitive coupling. It has been calculated that standard ISO cards with densities of 64 bytes may be constructed.

For those of you who wish further explanation of this unique technology please refer to the claims of PCT patent international publication number W0 95/14285 entitled *Capacitive Data Card System*

Capacitive Cards

Many variations of both materials and processes may be used to manufacture Capacitive Stored Value Cards. For example, financial restraints may dictate a lower cost card be used to implement a card system to replace food stamps, such that a less expensive PVC carrier would be used as a replacement for the specified Polyester carrier. In this case a trade off must be made between the environment and the cost of implementing social programs. Such considerations clearly lie beyond the technical merits of one manufacturing process over another.

Why are CoinCards non-rechargeable ?

Non destructive read frequency

Destructive write frequency

Each bit, a link of metal a few microns wide & a few hundred angstroms thick, is buried in the card making it impossible to reconstruct. In essence a PROM

Laser encoding/etching

Current patterns are 128 bits, projected densities of 512 bit are possible.

A) Small quantities of Cards (tens to hundreds of thousands)
Scanning laser encoding time 3 seconds/card

B) Large quantities of Cards (tens to hundreds of millions)
Projection laser system using a mask
Custom encoding for each vendor or vendor application
Encoding time under one second/card

Tel: (604) 360-0012 Fax: (604) 360-0866 E-Mail : bdoyle@coincard.com

Card properties a comparative approach

Card Type	Capacitive	Magnetic	Memory Chip
Cost	$0.20	$0.40	$2.00
Rechargeable	no	yes	yes
Contactless	yes	yes	no
Static electric Sensitivity	no	no	yes
Magnetic field Sensitivity	no	yes	no
End to end card bend	yes	yes	no

Alpha testing

Given the origins of this unique card technology, it is natural that it's market debut should be in Canada. DAI struggled, however, with choosing either parking or transit as the most suitable market entry point, before finally settling on a transit application. Strategically located on the Pacific rim BC Transit operates over two thousand vehicles in 65 communities carrying 140 million passengers per year throughout Canada's most westerly Province. CoinCard technology has been alpha tested by BC Transit, and based on the favorable results further implementations are now planned.

The small community which was chosen for the alpha test was Courtney on Vancouver Island with a population of 30,000 and a total bus fleet of eight buses. At the early planning stages BC Transit specified a simple two tier single ride fare structure. They therefore issued multi ride cards in two categories, full fare adult cards and discount fare student and senior cards. Physical specifications were for the passenger's reader/writer to contain an single LCD & LED pair visible to the passenger while inserting the card, and an additional LCD & LED display attached via a flexible cord which could be conveniently mounted to be visible to the driver. Operational specifications were for the message *insert card* followed after processing by the *number of fares remaining* to be displayed on the passengers display, and the *fare classification* to be displayed on the driver's display. The LED on the passenger display must change from red to green, and an audible beep must sound for a correctly tendered fare. A slightly louder buzz and a change to red, rather than to green to alert both the driver and the passenger of an incorrectly tendered fare. Additionally a special tone was to sound and the LED was to flash a message when the last fare was deducted from the card to notify the passenger of the need to purchase an new card. In short the specifications to DAI where to initially keep the test very simple with no consideration given to zonal fares nor to data logging.

Data Logging

Since each CoinCard has it's own unique identity, it is a relatively easy task to implement data logging. Ridership on particular routes, broken down into fare categories and time of travel, are all planned in future implementations. Each component of our CoinCard fare systems is "Smart". That is the card reader/writer and any accessory such as LCD, printer, or additional card reader has it's own micro processor and communicates over an I2C bus to all peripherals. This design provides ultimate plug and play flexibility. An infra red transceiver is used to download route information, and upload passenger usage information via a personal digital assistant such as an Apple Newton to allow data to be delivered to administration at anytime.

Tel: (604) 360-0012 Fax: (604) 360-0086 E-Mail : bdoyle@coincard.com

Potential of Multipurpose Fare Media

Workshop on Emerging Fare Collection Technologies

Miami, Florida

September 27, 1996

Daniel Fleishman

Multisystems, Inc.

MULTISYSTEMS

Introduction

- TCRP study: *Potential of Multipurpose Fare Media*
  - Study period: February 1996 - May 1997
  - Multisystems assisted by Dove Associates and Mundle & Associates

- Follow-up to *Fare Policies, Structures and Technologies*

Key Elements of Study

- Review current/emerging practices
- Identify transit, banking, customer issues/concerns
- Assess potential for multipurpose programs
- Develop guidelines for multipurpose arrangements

Review Current and Planned Practices

- Commercial payments (smart "cash cards")
- Transit (multipurpose arrangements, smart cards)
- Survey of transit agencies: costs, concerns, plans
- Discussions with financial institutions, vendors

Identify Transit, Banking, and Customer Issues

- Financial (costs, benefits)
- Institutional (arrangements, legal/regulatory barriers)
- Operational (different pricing policies)
- Customer-related (privacy, acceptance of media)
- Technological (type of media)

Assess Potential for Bank-Transit Cooperation

- Cost and benefits, advantages/disadvantages
- Nature of barriers and concerns
- Cross-cutting analysis of case studies

Develop Implementation Guidelines

- Assist transit agencies and financial institutions
- Summarize benefits and costs -- to both sectors
- Procedures to develop/implement joint programs

Increasing Use of Electronic Fare Media

- Transit moving toward electronic media & stored-value
  - magnetic stripe
  - smart cards
- Financial entities moving toward smart cards & stored-value

Intersection of Banking and Transit

- Use of EFT for media purchase
- Sale of fare media through ATM's
- Acceptance of credit cards on buses

Bank Interest in Transit Payments

- Quickly establish critical mass for cash cards
- Access to new customer base for other services
- Access to merchants affiliated with transit

Transit Interest in Joint Arrangements

- Reduce fare collection costs
- Get out of payments "business"
- Generate additional revenues
- Improve customer convenience
- Expand market base

Types of Multipurpose Program

- Regional transit fare integration
- Transit and other transportation (parking, tolls)
- Transit and non-transportation (retail, campus, telephone)

U.S. Examples

- Atlanta: MARTA/Visa/3 banks - VisaCash in stations
- Phoenix: MasterCard/Visa on bus
- Ann Arbor: campus card on bus
- SF Bay Area: regional integration (planned)
- Seattle: regional integration (planned)

Foreign Examples

- Sydney: multiple use
- Manchester: multiple use
- Denmark: multiple use
- Hong Kong: multiple use (planned)
- Toronto: regional integration (planned)

Customer Issues

- Potential acceptance of new media
- Privacy concerns
- Convenience of purchase for bus use

Operational Issues

- Accommodate differential fare structures
- Accommodate discounts for transit use only
- Serve occasional riders without cash cards

Financial Issues

- Who pays for equipment, cards, settlement, etc.
  - bank supplies equipment, cards?
  - transit agency pays transaction fees?
  - users pay for cards?
- Who receives benefits (cost savings, additional revenues)
  - fees from merchants
  - unused/expired value
  - "float" from prepayment

Technological Issues

- Contact card -- preferred by financial services
- Contactless card -- preferred by transit
- Magnetic stripe -- already in place at many agencies
- Combined cards -- cost, timing

Institutional Issues

- Transit agency concern re loss of direct control
- Constraints on agency ability to form partnerships
- Legal/regulatory issues
  - refunds for unused value
  - replacement for theft/loss of card
  - other EFT regulations

Institutional Arrangements

- "Closed" vs. "open" system
  - closed transportation only (WMATA, Seattle)
  - closed multipurpose (NYMTA)
  - open (MARTA, Phoenix)
- Possible evolution from closed to open

Advantages to Transit: Closed vs. Open

- Closed
  - retain control over fare collection
  - keep additional revenues
- Open
  - reduce costs
  - broaden customer base

Summary

- Transit agencies interested in reducing cash
- Banks interested in stored-value
- Potential for mutual benefits
  - transit: reduce costs, add revenues, expand market
  - banks: market for cash cards, revenues

Summary (cont.)

- Issues must be addressed
  - cost impact on transit agency
  - type of card
  - accommodating transit fare policies
  - availability of cards
  - customer concerns
  - legal/regulatory barriers
  - closed vs. open system
- Joint arrangements are evolving

Electronic Fare Collection Implementation: Insights from the Atlanta, Seattle and Ottawa Experience

Workshop - Emerging Fare Collection Techniques in Mass Transit
Florida International University, Miami
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Rod McDougall, Director
Doug Parker, Associate
IBI Group, Toronto
(416)596-1930

1. Introduction

The transit industry is gaining insight into the implementation of electronic fare collection systems. IBI Group has been recently involved in several such implementation efforts which span a range of environments and issues.

This paper will explore insights, on a variety of fronts, emerging from three of these efforts, in Atlanta, Seattle and Ottawa (Canada). First, a brief synopsis is provided for each of these projects. With this background, a range of key implementation aspects will be discussed

2. Reference Projects

2.1 Atlanta

Visa International is working with three different banks to trial an open stored value card system (contact smart cards), known as VISA Cash, in conjunction with the 1996 Olympic Games in Atlanta. Both disposable cards, each sold preloaded with stored value in varying denominations, and reloadable cards, issued initially without stored value but replenishable as needed until the card expiry date, are involved. The revenue collected in the creation of this stored value is pooled and distributed to merchants who accept stored value, based on the electronic transaction records.

The stored value will be accepted at a variety of retail merchants which tend to smaller value purchases, such as fast food and gasoline. Arrangements were made with the Metropolitan Atlanta Rapid Transit Authority (MARTA), for VISA Cash acceptance at each rail station on a limited basis. A VISA Cash Card Accepting Device (CAD) terminal was integrated into each of 129 turnstiles to supplement the existing fare media of cash, tokens and magnetic strip "Transcard" weekly passes.

IBI Group provided project management, coordination and technical assistance services on behalf of Visa International through the procurement, development, manufacturing, installation and integration stages.

2.2 Seattle

The Central Puget Sound Regional Fare Coordination Planning Team involves representatives from six transit agencies in the Seattle area. This group has been evolving a stored value contactless smart card for common use. A key consideration is establishing a revenue clearinghouse, to pool revenue from stored value replenishments and distribute this revenue to the agencies in accordance with customer fare transactions.

IBI Group has been involved in the regional system planning, including the procurement of equipment for use on a trial basis to gain operational experience to support the design effort. IBI Group has also been working directly for one of these agencies, Washington State Ferries, on design for the implementation of this equipment in their terminals and vessels.

2.3 Ottawa

OC Transpo in Ottawa, Canada has been completing a systemic assessment for fare collection operations and policy. A range of fare strategies were evaluated, including a do nothing option, one which maintained the existing fare collection equipment (mechanical fareboxes) but introduced some policy innovations, as well as one which included an electronic fare collection system based on contactless smart card technology and a radical customer loyalty based fare policy. A recommended fare collection strategy has emerged, involving electronic fare collection, a range of innovative fare policies and a card revaluation system utilizing third party vendors.

OC Transpo has a high percentage of frequent users (about 75% use a monthly pass) and the highest market penetration (as measured by the number of annual rides per capita) of any system its size in North America, indicating that the ridership has been responsive to the deep discounts available through the pass. Consideration is being given to the development of a customer loyalty scheme which would be aimed at increasing market penetration with riders having a current ride frequency which does not support use of the pass. By using information stored on the smart card, it is possible to offer progressively increasing discounts on individual fares as the cumulative ridership increases over the course of a calendar month.

Another feature of the strategy is to enhance the opportunities for customers to revalue their smart cards. One option is on-board revaluation in conjunction with the fare transaction, based on prearranged minimum stored value balance thresholds and direct account debit payment arrangements. Further measures to increase the accessibility and convenience of revaluation are more dependent on achieving partnerships. For example, most Ottawa pay telephones are already equipped with smart card reader/writers and message displays. With alternative smart card acceptance devices which support both contact and contactless smart cards, every pay phone could become the equivalent of an ATM for smart card revaluation purposes.

IBI Group has provided broad technical assistance and program planning support, working closely with a program steering committee, customers and various other stakeholders to achieve consensus on difficult issues.

3. Insights Gained

3.1 Objectives

Agency benefits fall primarily into two categories - either apparent to customers or not. Both types of benefits are valuable to agencies, to enhance ridership and reduce operating costs.

Benefits apparent to customers include increased convenience, security and more flexible loyalty reward mechanisms. The stored value card avoids the need to carry exact change. For contactless cards, convenience is increased further through avoiding the need to insert the card at any particular orientation or to even remove it from the purse or wallet. The card can also be used to remove the need for printed transfers.

The stored value card offers increased security for customers in that the identification number for a lost or stolen card can be reported and a refund can be provided. However, the policy decision on whether or not to provide refunds would only be under the control of the transit agencies if it is a closed system where they control the clearinghouse and issuance. Also, loyalty based discounts can be provided very flexibly, responding directly to usage history information recorded on the card

The agencies can benefit significantly from the reduced use of cash and tokens, since administrative handling overhead is substantial (typically fare/administration costs are on the order of 10% of revenue). Also avoided is the potential for leakage during cash/tokens handling. Magnetic stripe card based approaches also reduce cash/tokens usage, but smart cards offer increased security against card copying, fraudulent value creation, etc., and are less expensive when considered on a life cycle cost basis.

The experience gained through operating electronic fare collection can provide a foundation for subsequent involvement in other electronic collection and electronic data interchange opportunities. Similarly, the experience in new partnering relationships can broaden perspectives and can foster innovative new institutional arrangements and opportunities.

Agencies can increase their understanding of trends and patterns in fare payments of their customer base, since usage of the smart cards can be analyzed through the card identification number. Although this identification number can be unconnected with any information about the card holder, to retain their anonymity, any customer information retained on a voluntary basis could only enhance this understanding.

portion of the transit agency ridership acquire a card and also perhaps use it with other participating merchants.

The primary opportunity for a transit agency in arranging acceptance of an open system stored value card is to avoid the need to establish their own card related infrastructure (such as card issuance and revaluation facilities, transactions acquisition and settlement, etc.). Some agencies feel that such systems, and perhaps even revenue collection in general, are not part of their core business of delivering transit services and that their involvement should be correspondingly limited. In the case of a group of regional transit agencies, participation in an open system can also reduce the need for the often very difficult interagency coordination necessary to establish and operate a closed system.

In joining an open system and declining to leverage their substantial customer base into creating a regional system in which they have significant control over issuance and the clearinghouse, transit agencies do miss certain opportunities. For example, the clearinghouse operator can generate additional revenues from the prepaid balances and in transaction fees from other participating merchants.

There is also some concern in joining an open system over a reduction in agency contact with their customers, if they are no longer be involved in selling fare media to users of the open system cards (even if the transit agency arranges to provide open system card reloading at their fare media sales locations, there would be reduced contact since there would be many other reload locations such as ATMs available).

A challenge, faced by Visa International, MARTA and the banks involved, is to adapt the conventional open system from that provided to retail merchants. At MARTA turnstiles, for example, the CAD was adapted from the retail version to eliminate steps involving initial stored value balance display and customer confirmation of the transaction amount. Also, rather than a single modem for daily batch transmission of transaction records for settlement from a merchant's single CAD, the transit application required adjustment to a multidrop communications configuration, with a single modem handling all CADs for a particular station.

3.4 Technology Developments

Currently, the primary smart card technology choice lies between contact and contactless interfaces. The contact card is more mature technologically, with a standardized physical interface and standards for terminal communications emerging through joint efforts of the financial institutions developing the emerging open systems. A more recent innovation, the contactless card is increasing in popularity.

The emerging open systems currently are implementing only contact smart cards. The transit industry were first to embrace the contactless card to help support customer convenience and very brief transaction times. But customer convenience in particular is also very important to retail smart card acceptance applications and the contactless cards

3.2 Coordination Between Agencies

Coordination between diverse public agencies can be difficult at best and in some cases virtually impossible. This does not reflect a lack of effort or good will on the part of the agency participants. Rather, it is a consequence of the typical conflict between the objectives of individual agencies and the objectives required for adoption by the group to achieve success.

The Seattle Regional Fare Coordination Planning Team is an example of interagency cooperation which has been yielding success. A key factor was the established Transit Operators Committee, through which the agencies of the Region had developed working relationships and common interests over time. This has tended to make it easier for these agencies representatives to perceive common interests in the opportunities associated with a regional fare coordination initiative.

On the other hand, many other regions with multiple agencies but no significant history of interagency coordination face more difficulty. There are potentially divisive issues to be faced. For example, a shift from flat fares to fare by distance in support of regional fare integration can lead to resistance on the part on agencies who perceive they could suffer. Fare policy issues are often regarded purely as political issues.

3.3 Integration with Emerging Open Systems

In general terms, the difference between closed and open systems in this context relates to acceptance. If a card is accepted only within a limited set of vendors it is generally referred to as closed, while an open system would provide for multiple card issuers and more universal acceptance (ideally approximating the universal acceptance of cash). For the most part, an open system would involve issuance and clearinghouse operation by a financial institution, but with issuers and merchants having no substantial role in clearinghouse or system operation.

Initial transit implementations have involved closed stored value card systems. A typical example would be the intended regional fare system for Seattle, where a consortium of regional transit agencies will arrange for stored value they issue to be accepted at each of their facilities. Regardless of the extent to which financial institutions or other private sectors partners become involve in the clearinghouse or other aspects of system operation, it would remain a closed system because its scope is not initially intended to reach beyond the local context and would likely always have transit agencies as its most substantial participating merchants.

VISA Cash is structured as an open system, where multiple banks become card issuers and any merchant worldwide could be a participant but there is no issuer or merchant role in operating the system. Emerging open systems are extremely interested in transit agencies as early merchant participants. The primary reason is the substantial potential boost in early market penetration and transaction volume for their stored value card if a substantial

and terminals are emerging as the increased reliability alternative. Given the demand for contactless technology from major merchants such as transit and the other benefits, the financial institutions responsible for the emerging open systems are giving increased attention to supporting a contactless interface. The Atlanta implementation has highlighted issues associated with contact card acceptance in the transit environment.

The desire to support both contact and contactless interfaces is driving the smart card industry in their development of hybrid card technology. These developments currently remain in relatively early stages, and the term hybrid card involves a variety of alternative architectures. The basic architecture involves two sets of chips with their respective interfaces which have been encapsulated within the same physical smart card. Alternatively, the contact and contactless chips can be networked together or even share memory.

The operational hypothesis behind these developments is that, for the short term anyway, the emerging open card systems will establish a revaluation infrastructure which supports only the contact interface. To use the same card and a contactless interface for merchants such as transit involves arranging to access the open system stored value through the contactless interface. Mechanisms are envisaged where the a purchase transaction from the perspective of the open system has the purpose of creating stored value on the card accessible through the contactless interface. An additional complicating factor is the potential need for a transit agency to access electronic fare media in not only stored value form, but also stored rides and period passes. Significant effort lies ahead to develop the business processes to support acceptance for the emerging open system cards through contactless interfaces.

3.5 Deployment

Transit offers a range of physical and operational environments associated with various transit modes, including rail, bus, and ferries. These differences in environment can have a significant impact on the specific deployment issues for electronic fare collection.

For the rail mode, one of the major issues relates to whether fare collection involves entry through a physical barrier or whether proof of payment inspection is used.

Where a physical barrier such as turnstiles exist, as in Atlanta, a primary issue is the physical and electronic integration of the card accepting terminal into the turnstiles. Although challenging, this was achieved in the Atlanta effort for each of the several different installed makes and models involved.

For proof of payment, the basic requirement becomes equipping the inspection personnel with portable card reader devices. Continued reliance on a paper ticket for inspection in problematic for several reasons, including the need to avoid creating an unnecessary entry barrier for period pass passengers.

For urban bus and rail systems, a major issue can involve supporting fare by distance arrangements. This was a consideration in the Ottawa project. The retrofit of existing rail entry/exit barrier systems would be more like the barrier integration aspect just discussed. The primary issue here is more related to the opportunity to support fare by distance for rail/bus and bus trips, somewhat problematic with conventional fare collection techniques. One important choice is between fare collection on exit and an initial fare collection on entry which is later adjusted on exit. Issues include ensuring that the exit transaction occurs in a bus environment and determining the variable fare upon bus exit (by location vs by elapsed time, for example).

For ferries, an important issue is to deal with vehicle traffic. The Seattle effort for Washington State Ferries is examining deployment for this mode. One issue is whether to have the driver conduct a smart card transaction directly with the terminal as for any other transit mode or to provide for longer range contactless interface, typically by inserting the card into a "sleeve" providing a radio frequency or optical interface or by providing a connection to an in-vehicle mounted radio frequency interface transponder. Another issue is that the existing fare structures for many ferry operations are very complex, with vehicle fares varying with passenger occupancy and involving various vehicle classification surcharges. This can affect the overall feasibility and techniques for automating vehicle fare collection.

3.6 Integration with Existing Fare Systems

Each transit agency has an existing fare media sales and collection system with which an electronic fare collection system must integrate. In most cases, there is not an intention to eliminate existing fare media but rather to complement them and reap the benefits of the shift to the new electronic fare media.

It is to some extent possible to take advantage of existing fare systems infrastructure to help support the new system. For example, existing monthly pass issuance, fare media sales locations and third party concessionary vendors can potentially support card revaluation and/or issuance. On the other hand, electronic fare collection equipment typically requires a communications infrastructure to transfer revaluation and fare collection transactions to the clearinghouse.

Another major category of integration issues are associated with other existing "back office" systems. For example, audit systems will typically require the periodic submission of various data. The design of the electronic fare collection needs to identify all requirements for information transfer with external systems and provide for their support. Other types of systems with which electronic fare collection may need to be integrated include maintenance, operations monitoring and service planning.

3.7 Innovative Pricing

Existing fare media require that the passenger commit to a certain level of ridership through lump and non-refundable prepayment to access a frequent user discount. A certain group of relatively infrequent customers do not receive any discount because their preplanned ridership does not induce them to purchase a multiride ticket or period pass. At the other extreme is the extremely frequent transit user who ends up through a period pass receiving a very large number of trips for much less than they would be willing to pay if they had to cover each trip individually. Also, once the decision has been made to purchase a multiride ticket, there is no mechanism to reward the user for incremental increases in ridership. Someone who consumes their multiride ticket within one week receives no greater discount than someone who does so in two months.

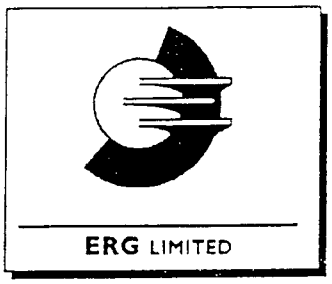
A major opportunity associated with smart card technology is to directly and flexibly reward increases in ridership. Information on the cumulative level of ridership through a calendar month, with various transit agencies, can be carried with the passenger and used to provide an increasingly greater fare discount immediately. This discount can be communicated to the passenger on the spot to improve the association between the discount and the increase in ridership.

Incentives can also be provided to reward behavior which supports a wide range of other potential policy objectives. For example, a discount can be provided for interline trips spanning multiple agencies. If the card is used for parking, a discount on the parking price could be provided if transit is used. Reduced prices can be provided for off-peak travel or to encourage passengers to adjust their travel patterns to utilize a new or underused facility.

4. Conclusions

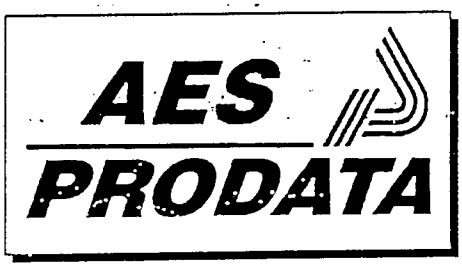
Some of the earliest deployments of electronic fare collection for transit agencies, using smart card technologies in a variety of environments and institutional arrangements, are becoming established. This paper highlights some insights with regard to key implementation issues which IBI Group has observed through our close involvement with three very innovative deployment initiatives in Atlanta, Seattle and Ottawa (Canada). Although each of these efforts contributes a wide variety of ideas, there is a dominant contribution in each case.

The Atlanta trial at MARTA for VISA Cash acceptance at rail turnstiles is the first major opportunity to assess integration with an emerging open stored value system. The Seattle regional fare integration effort is emerging as a model for achieving progress in interagency coordination towards a "seamless" fare environment in a complex urban region. In Ottawa (Canada), with its high transit market penetration and relatively reduced needs for interagency coordination, an opportunity is emerging for the assessment of innovative fare policy approaches which exploit smart card technology to achieve flexible ridership loyalty reward mechanisms.



IMPLEMENTING SMARTCARD PROJECTS IN TRANSIT: A COMPARATIVE STUDY OF HONG KONG AND MANCHESTER, UK.

Floyd Diaz
Vice President - AES Prodata Canada



151 BRUNEL ROAD, UNIT 18
MISSISSAUGA, ONTARIO
CANADA L4Z 2H6

1 INTRODUCTION

1.1 HONG KONG

In June 1994, Hong Kong entered the world of Smart Cards by announcing the signing of a Contract for one of the largest Contactless Smart Card multi-application projects to date. The Contract requirements were not for trial, or a pilot but a full blown implementation which will touch the daily lives of nearly every one of the 6 Million inhabitants of this thriving South East Asian City.

The contract was signed between Creative Star and AES Prodata, the Automatic Fare Collection division of ERG Limited, and calls for the provision of 3 million Contactless Smart Cards and 5000 pieces of processing equipment and adaptation kits.

Creative Star is jointly owned by the five major transport operators in the area including the Mass Transit Railway Corporation (MTRC), the Kowloon-Canton Railway Corporation (KCRC) Heavy and Light Rail Divisions, the Kowloon Motor Bus (KMB), Citybus and the Hong Kong and Yaumati Ferry (HYF).

1.2 THE GREATER MANCHESTER ONECARD

The Greater Manchester Passenger Transport Authority identified the need for a new ticketing system to replace the existing technology used for processing prepaid tickets to concessionary riders. The task of selecting a suitable alternative and implementing the system was assigned to the Greater Manchester Passenger Transport Executive (GMPTE). The GMPTE linked up with AES Prodata to form a commercial organization, Prepayment Cards Manchester Limited (PCML) which was set up on November 01, 1993 to :

- set up the new transport application;
- develop a generic electronic purse.

The pilot was run between June and August 1994 north of Manchester and involved 2,000 Contactless Smart Cards, read/write equipment on 120 buses and four add value devices.

2 BACKGROUND

2.1 HONG KONG

The Hong Kong public transportation network is somewhat unique because it consists of various profitable private operators. There are in excess of 3 million passenger trips made daily on a complete multi-modal system made up of ferries, buses, a subway and light rail.

The MTRC has operated a fully automated fare collection system since its start of operations in 1979. The basis of the system is the full oxide magnetic plastic card principally being used for single journey and stored value tickets operating in an entry/exit controlled environment.

In 1984, the Kowloon Canton Railway adopted the same system allowing passengers on both railways to pay for their journeys using the renamed Common Stored Value Ticket (CSVT). The CSVT was further extended when the Kowloon Motor Bus and City Bus installed CSVT readers on their feeder routes to the rail systems. In addition to transport, small scale implementation of non-transport applications involving Photobooths and fast food service outlets used the CSVT as a payment method.

2.2 GMPTE

There are 250 million journeys made each year on Greater Manchester transport. Five years ago the Greater Manchester Passenger Transport Executive (GMPTE) faced the problem of how to replace the existing technology used for processing a prepaid card known as a "Clippercard" on public transport in Greater Manchester. The system was 14 years old, its technology was inadequate and the operators were not happy with it. The card itself was made of cardboard; a device on board the bus took clips out of the card for each journey made.

The GMPTE has to distribute the subsidized ridership budget between 70 bus companies. With the current system every six months a data collector would board the bus for the day and record the subsidized transactions. The operators were reimbursed on the basis of this 1% sample. There was no allowance made for variations in the pattern of use such as half day closing. The data collection and associated system alone was costing the GMPTE $1,700,000 each year.

3 BUSINESS OBJECTIVES

3.1 HONG KONG

In response to continuous improvement and customer service strategies, in 1993 the MTRC carried out a review of its fare collection technology and the future development strategy that should be followed over the next decade. The conclusion of the MTRC was that a system based upon Contactless Smart Card technology should be implemented. Following the formulation and provisional acceptance of an internal business plan, an independent review of the project was carried out by Consultants Coopers & Lybrand which confirmed that there was a strong prima facie case for developing a broadbased Transport Operators Smart Card System in Hong Kong. The review further recommended that developments into other non-transport applications should be considered, with however, the requirement of establishing the critical mass of card holders through the transport application being the prime objective.

To accommodate both the transport and other applications, the Contract specifications were written such that the card and the system will consider a wide variety of independent fare policies and structures. No constraint by the system is placed on the Service Provider in the application of a particular fare, charging policy or eventual migration towards an electronic purse.

3.2 GMPTE

The system to replace the Clippercard will enable the GMPTE to:

- streamline the operation of the concessionary fares scheme and record concessionary pass and permit transactions;
- provide a framework through which inter-operator and multi-mode tickets can be developed further;
- provide a means of reducing or eliminating cash payments on buses and speed up boarding;
- provide a means of integrating payment for bus, tram and rail journeys;
- expand the use of the electronic purse in the future.

The GMPTE has a concessionary budget of $50 million per year, funded by local taxpayers. This foregone revenue needs to be allocated between 70 bus operators. Under the proposed Contactless Smart Card System, the allocation would be

based on every card used so it would be highly accurate, making it easier to calculate exactly how much each operator is entitled to. The statistics would also give a better indication of usage than the present Clippercard.

Savings using the new system would include:

- ***streamlining the data collection activity*** - the previous system required the data to be collected manually. The cost of that collection was $975,000 per year. The data collection with the new system will be of a much higher quality and will take no man hours to collect;
- ***reducing the areas of abuse*** - such as people who are not entitled to concessionary cards making use of them. In Merseyside they estimate that up to 30% of transactions fall into this category. For the business case a very conservative figure of 5% resulted in a savings of $2,500,000 per year;
- ***reduction in commission payments*** - currently the GMPTE pay Post Office Counters Limited $400,000 per year for selling the Clippercard; under the new system this will fall to $200,000. A small commission will be paid to retail outlets, the benefit to them is the incentive for people to shop there;
- ***reduced manning at rail stations*** - up to $250,000 per year can be saved by having unmanned stations.

The GMPTE is looking for a payback of a $17,000,000 capital investment in seven years exclusively through savings in transit operations. A company called Prepayment Cards Manchester Limited (PCML) has been set up as a commercial company (owned 50% by the GMPTE and 50% by AES Prodata) - it will get its income from other interested parties, so the local authority will get the system free.

4 WHY CONTACTLESS?

4.1 HONG KONG

The principal developments which has enabled Smart Cards to compete against the magnetic medium has been the rapid reduction in the costs of the cards and read/write devices and the emergence of Contactless technology.
Silicon memory costs for Smart Cards have declined over the last 10 years by between 30 and 50 % per annum, while in comparison the plastic magnetic card costs have remained more or less static.

The importance of card and reader costs on a project viability can be appreciated when considering the initial order quantity for the Hong Kong project (3 Million Cards and 5000 Processors). For any card project to be financially viable, not only must the initial capital cost of setting up the system and infrastructure be considered but also the significant whole life operational cost and the potential liabilities in the event of failure or fraud.

The average in-service life of the present recirculated magnetic card within the Hong Kong environment is approximately 120 uses. In contrast, Contactless Smart Cards have a minimum guaranteed EEPROM of 10,000 read/write operations with figures as high as 100,000 being quoted. The fact that Contactless Smart Cards are solid state and will have negligible mechanical handling should ensure that the specified physical life of between 7-10 years is realized.

The other major technological development, essential to obtain the operational throughputs in a mass transit environment is that of the contactless or proximity communications interface which enables the Smart Card to complete a transaction without the need for contacts or insertion into any device or ticket transport. If combined with card processor authentication and data encryption it provides a faster and more secure transaction than mechanical magnetic ticket transports.

Significant additional benefits which have always favored the Contactless Smart Card are low maintenance costs for the processing devices, security and data capacity. While the present Hong Kong magnetic system has a high reputation for reliability and customer acceptance, the maintenance and ticket recirculation costs are high. Regular maintenance and consumable replacements are required as well as skilled technicians needed to service the mechanical components. In comparison the Contactless Smart Card processors are entirely solid state and require virtually no preventative maintenance.

4.2 GMPTE

The GMPTE examined various technologies to replace the Clippercard and the pass permit system. These included magnetic stripe (both high-coercivity and low-coercivity), Contact Smart Cards and Contactless Smart Cards. The choice of a Contactless Smart Card was based on the following requirements:

- ***reliability*** - Contactless cards are particularly suitable for transport ticketing because they are robust, waterproof and heat-proof. There is no component exposed and thus little danger of contamination or deliberate vandalism. With both contact and magnetic stripe technologies there would need to be a reader with an aperture. This would present a problem at unmanned stations because readers would be vulnerable to vandalism. Costs of the entire system over its life were considered. Availability of the reading equipment has to be 99.98%. Magnetic readers are much less reliable than Contactless Smart Card readers and require far more maintenance;
- ***speed*** - with ticketing in transport applications it is imperative that the method chosen is speedy. Contactless cards are quick and easy to use, reducing passenger dwell times. Contact and magnetic stripe cards would require placing the card in a reader and ensuring a reading was actually taken, which would increase time for the transaction to be completed. Contactless cards reduce the "fumble factor" associated with other card technologies;
- ***security*** - fraud is difficult to detect in transport because of the rapid nature of the transactions. In order to promote the use of the card as an electronic purse, the technology has to be of a secure nature. With the Contactless card, it is possible to tell when people have deliberately tried to damage cards in order to gain free travel. Previously it was not possible to tell whether the card was actually damaged or the holder was trying to defraud the bus companies. Magnetic stripe cards are less secure than smart cards but contact and contactless cards are equal in this area;
- ***user-friendliness*** - the new system has to be user friendly. If it isn't then there is added time for the transaction to be completed and more importantly, the users may reject the whole scheme. Research has shown that users prefer the contactless card.

5 SYSTEM OVERVIEW

5.1 HONG KONG

Technically, the system can be logically considered in four interconnected layers:

5.1.1 LAYER 1: THE CENTRAL CLEARING HOUSE

The prime function of the Central Clearing House will be to maintain the central transaction records of each Contactless Smart Card. The transaction record will be sent to the Clearing House and recorded against the Contactless Smart Card account on each transaction and an audit trace number will be assigned which will provide a sequential check to indicate any duplicate or missing transactions. System performance and accounting reports will be generated and distributed electronically to the Service Providers. The card issuing equipment registration databases will also be maintained by the Central Clearing House.

5.1.2 LAYER 2: SERVICE PROVIDERS CENTRALIZED DATA PROCESSING

The Service Provider Central Computer (SPCC) will collect, process and distribute data from and to each of its primary locations. For example, the MTRC will collect transaction data from each of its stations and deliver through data links to the Central Clearing House. The SPCC acts as a hub data concentrator for the Service Provider and carries out regular data transfer to the Central Clearing House. The Service Providers Central Computer will consolidate the data for generation of the Service Providers own comprehensive management and accounting reports. In addition the SPCC distributes system data such as blacklists and fare tables. The Service Provider has complete and independent control over the fare policy and levels of detail in management reporting.

5.1.3 LAYER 3: SERVICE PROVIDER LOCAL MONITORING AND DATA PROCESSING

5.1.3.1 Fixed Installations

At the local level, in the case of fixed installations such as the MTRC/KCRC stations, a workstation is provided with connections to each piece of Contactless Smart Card processing equipment. The data is sent periodically to the SPCC and also retained locally until data receipt is verified. In addition to the data processing role the workstation acts as a control and monitoring device for the local network configuration. Equipment status is monitored and alarms will sound at the workstation location.

5.1.3.2 Mobile Installations

For the Bus Operators, data will be collected from the buses when they return to their respective depots. Transponders located at the depot entrance or fuel bays will automatically establish data transfer using a wireless Local Area Network (LAN) between the bus and the Bus Depot Computer which carries out similar functions to that of the fixed installation computer. The LAN employs spread spectrum propagation developed for interference free communications.

5.1.4 LAYER 4: CONTACTLESS SMART CARD PROCESSING EQUIPMENT

The interface between the Patron and Service Providers fare collection equipment will be via the Contactless Smart Card processing equipment. In the case of the Transit Operators which already have fare collection equipment in place, this will involve integration into existing hardware such as fare gates while others such as Bus Operators will have full self contained units including local data processing, communications interface and passenger displays. When the electronic value is depleted or when the Patron wishes to top up the Contactless Smart Card, a variety of methods will be available. Value may be added using Add Value Machines (AVM) strategically located throughout the territory. The AVMs will accept cash and/or bank electronic funds transfer. Alternatively, the Patron may hand cash to the Service Providers Customer Service Center Operator for the electronic value to be transferred onto the Contactless Smart Card.

5.2 GMPTE

To prove the eligibility of concessionary passengers it was vital to have the holder's photograph on the card. This feature also acts as a deterrent to those who steal cards in the hope of using them for themselves. The electronic purse function does not require a photograph but research has shown that people are more likely to look after a card with their own image on it.

At an issuing station, the card holder's details are collected (name, concessionary type, date of birth, etc.) and the image is placed on the Contactless card. The computer writes the rules for that card on the chip, such as conditions of travel, and the card is charged with value ready for the first use.

The equipment on the bus includes a reader for the cards and a terminal for the driver that also issues paper tickets. The driver's terminal uses a data module to upload and download information, and the depot computer also has a data module read/writer to transfer information from the depot computer to the driver's terminal, rather than using the wireless LAN as in Hong Kong.

The computer at the depot holds various information in its database. At the beginning of a shift the driver will enter his or her data module and his number into the reader. The reader then loads up the data module with the latest hotlist (a list of reported lost or stolen cards), service number, time and changes if any to the fare tables or PIN details. The driver then uses the data module as part of the sign-on procedure at the bus and all information is loaded into the driver's console in real time. When the shift is completed, the driver signs off and the data module is returned to the reader in the depot where the day's transactions are transferred to the computer's database.

If a hotlisted card is presented to the driver the reader will inform him of the cards status and appropriate action can be taken. At the same time the reader on the bus will block the card. This ensures that a hotlisted card cannot be used unless it is subsequently unblocked. This can only be done at the point where the card was first dispensed. If and when its use is attempted the technology has its own safeguards which are set in motion. Bus and rail inspectors will have portable readers to enable them to check the validity of passenger cards.

The settlement centre will process transaction data and the information necessary for settlement to service providers and sales agents. The centre will also hold customer and card usage data, it will monitor card transaction data and deal with lost or stolen cards.

6 RESULTS

6.1 HONG KONG

In late November 1995, Phase 1 of the implementation schedule commenced with 20,000 Contactless Smart Cards, 40 Smart Card Read/Writers installed on buses, the light rail and the subway. In the months of December and January there were 750,000 transactions without one reader failure. This further supports the claim that Contactless technology will substantially reduce the maintenance requirements of the front end equipment. Of the 20,000 cards issued, 9 were returned because they did not function properly. Creative Star's confidence in the system is evident in the fact they have authorized full system wide delivery in late 1996.

6.2 GMPTE

Once the GMPTE made the decision to use Contactless Smart Cards, it was up to the PCML to move the project ahead. Between June and August 1994, a trial was conducted using the card and card reading equipment. The trial was held in the north of Bolton - a district of Greater Manchester. There were 2,000 cards issued to school children and 500 to senior citizens, all of whom were frequent bus users. One hundred and twenty buses owned by four operating companies were fitted with card reading equipment, and card charging devices were installed in four locations.

In choosing the pilot the GMPTE needed a busy route; one that covered an area predominantly served by buses. Three of the four operators taking part had depots in the area and the catchment area also covered four schools as well as a large local supermarket for recharging the cards. The objective was to amass 25,000 transactions in order to test the robustness of the system, in actual fact there were 45,000 transactions.

6.2.1 PASSENGER'S PERSPECTIVE

During the trial the Contactless card became the main method of payment for 74% of the total sample. Identified passenger benefits include:

- simplicity of use,
- flexibility in use - if passengers wish, they can stop using the card for a period and they will not lose any value,

- refunding lost or stolen cards,
- easier, faster, trouble free payment.

Senior citizens often have problems trying to identify coins and generally handling change. With the previous system it was easier for mistakes to be made and Smart Cards reduce the problems of passenger change handling and drivers making change.

6.2.2 BUS OPERATOR/DRIVER'S PERSPECTIVE

Most drivers identified "speed/less time involvement" and "ease of use" as the major benefits. Drivers highlighted the fact there was no cash to handle. The system was seen as being more efficient, faster, less trouble for drivers and harder to defraud.

The drivers said it reduced the stress level of the job. Previously they had to decide for themselves whether someone was using a stolen or outdated card. Often they came across people who did not want to accept the driver's decision and the drivers were unhappy with the way they were being treated by the passengers. Now the drivers get increased job satisfaction through the knowledge that the right passengers are receiving concessionary fares and their employers are in receipt of all revenues due to them.

6.2.3 PCML PERSPECTIVE

Reduced administration means there is a time and cost saving for the GMPTE and because of the hotlisting function, there is less abuse through lost or stolen cards.

Substantial savings can be made on the previous method of data collection and the statistical information collected "on-bus" with the new method is highly accurate. Other benefits include:

- "on-bus" and depot cash handling costs are reduced;
- boarding times are reduced as the exact fare is always tendered;
- operators can target markets and introduce new and innovative prepayment methods.

7 FUTURE PLANS

7.1 HONG KONG

In longer terms it is expected that the Contactless Smart Card will be extended into other applications providing more utility to the card holder further reducing operational costs to the Service Providers. The design of the system has allowed for future applications, with the initial focus clearly on transit. The Service Providers will act as "Agents" to the Central Body and can actively search for applications for the Contactless card outside of transit. The Service Providers will collect all transaction records, transit or otherwise, and route them to the Central Clearing House. Service Providers will negotiate the commercial arrangements for their service and have responsibility for the disbursement of revenue to participants.

7.2 GMPTE

The "OneCard" will initially be used on buses, rail and the Metrolink. The card will have space for 70 loyalty pockets with 16 running at any one time; British Rail is interested in using this facility to offer frequent travel discounts. One of the functions of PCML is to develop the electronic purse, the GMPTE feels that critical success factors for an electronic purse scheme to work are:

- a ready made application (where customers have become used to the idea of using a prepayment card);
- a critical mass of cards already in circulation;
- a set infrastructure in place and an organization willing to support it;
- more outlets/devices such as ATMs where card holders can add value to their cards.

A transport application is an excellent venue for introduction of an electronic purse because of the above mentioned factors. In Manchester 600,000 - 700,000 people will have to use the card because they are concessionary passengers. The infrastructure for this application could readily be used for an electronic purse and PCML is willing to support this idea. Research shows that there are 200 billion cash transactions under $30 every year in the UK, 80% of all cash transactions. Most transactions tend to be carried out locally, within three miles of where the user lives or works. The GMPTE firmly believes that the "OneCard" could be used as a substitute for a large portion of the cash transactions in Greater Manchester.

8 CONCLUSIONS

There are many similarities to be drawn from the Hong Kong and Manchester examples. The first and most critical is the choice of fare media - Contactless Smart Cards. Even with the emergence of Contact Smart Cards in the telecommunication and financial markets, transit operators felt it was in their best interest to move ahead with Contactless technology. A contact card presents many of the same operational and maintenance problems that are encountered with magnetic technology.

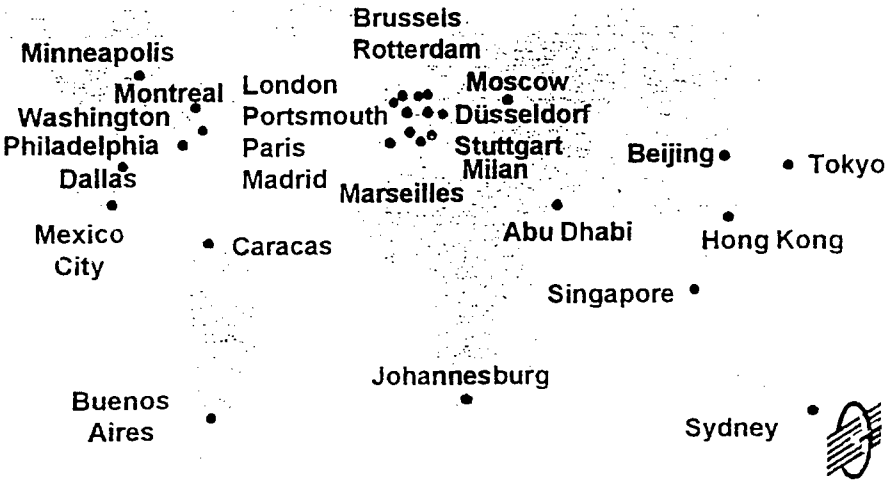
Governance is also an issue when dealing with a regional system. When there are several independent Service Providers participating in regional system, it is vital to have one governing body to act on behalf of all the participants. This makes the whole tendering process, evaluation of potential vendors and implementation more manageable and less costly.

Both transit systems viewed the extension of the Contactless Smart Card beyond transit and designed the system accordingly. Around the world governments are reducing transit subsidies and/or privatizing so it is beneficial to have a system that will allow for alternate revenue streams. A common denominator in both systems is using transit to generate the "critical mass" of card holders, then expand the utilization to other high volume low value vendors.

The next logical step in this whole Contact/Contactless Smart Card issue is the emergence of a Smart Card that is capable of using both interfaces. This development is being undertaken by many of the major Smart Card manufactures and I would expect a dual card to be developed in late 1997, early 1998. AES Prodata, through our Belgian affiliate, has been contracted to provide a fare collection system in Valenciennes, France, that will use a hybrid Smart Card - both Contact and Contactless. The participants in the vendor consortium are AES Prodata, Bull (CP8 Transac) a world leader in Smart Cards, and Resarail 2000 which is a subsidiary of the French national railway SNCF. The project involves a multi-modal transport system and a multi-service use of the card (electronic purse) covering a population of 340,000 people. Hopefully, next year at a similar forum, there will be a presentation of the first major project in the world involving a hybrid Smart Card.

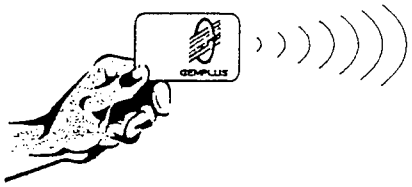
GEMPLUS

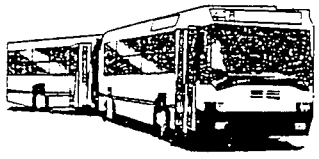
Gemplus Worldwide



PARKMETR (357)

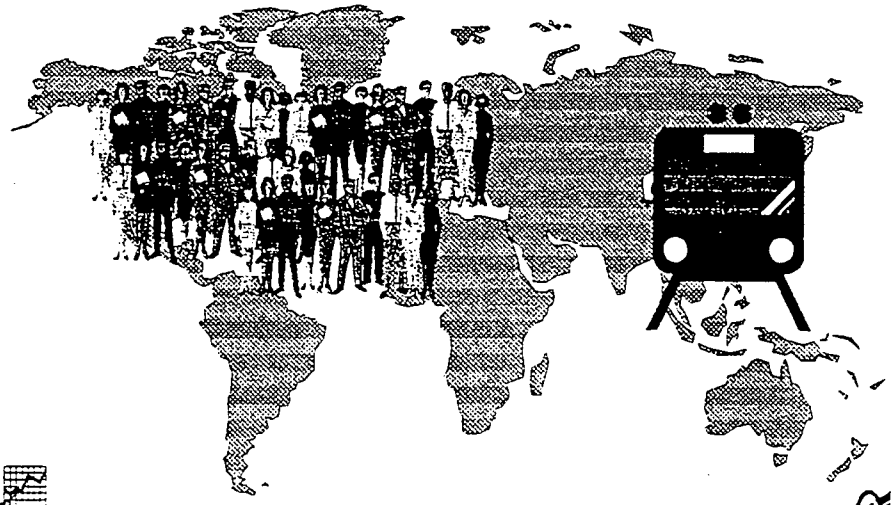
Contactless Cards For Public Transport





Fast, Easy, and Smart

Public Transport Worldwide



Source : UITP

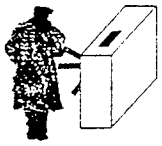
543 Million Passengers Each Day

TELETIC2 (553)

Why Contactless Cards ?

- The Operator's concerns

- Survey results



- Comparisons between fare media

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3

The Operator's Concerns (1)

- Speed / Throughput
- Passenger handling convenience
- Additional user services
- Intermodality
  - Bus / Subway / train / tramway / ferry

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The Operator's Concerns (2)

- Flexible fare structure
  - monthly pass
  - stored value ticket
  - peak / off-peak hour tariff
- Accounting accuracy
- Revenue security
- Total cost over system life (7 to 10 years)

Operators need more sophisticated fare media

Surveys Results (1)

- Done during field trail in Helsinki , Valence, Sydney
  - 98% found the contactless cards very easy
  - 87% found it easier than the magstripe card
  - 65% didn't find a preferencial position of the card
  - 70% found it faster than the magstripe card

The most accepted fare media by users

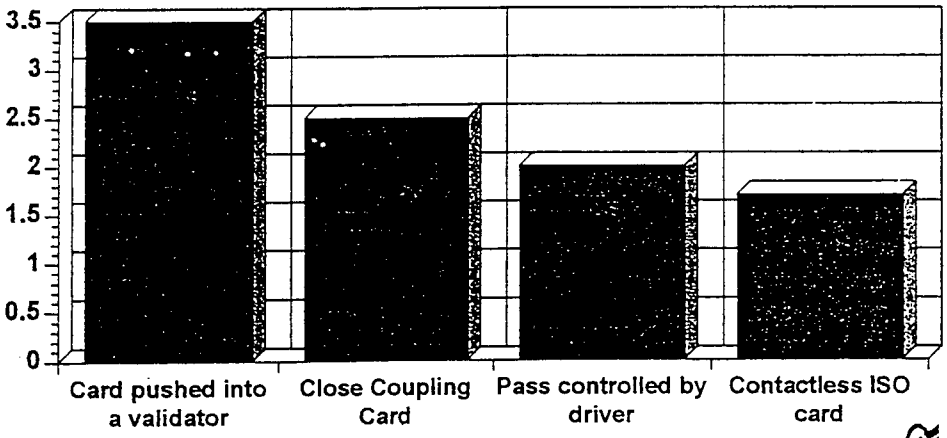
Survey Results (2)

- Field return :
  - Close coupling cards : > 10%
  - **Contactless cards : no returns after 500.000 transactions**
- Maintenance costs almost zero

Contactless card is the most reliable fare media

Survey Results (3)

Passing Time Comparison (in seconds) :



Contactless card is the fastest fare media

Comparison : Fare Media

++ : Good
+ : Fair
- : Poor
- - : Not viable

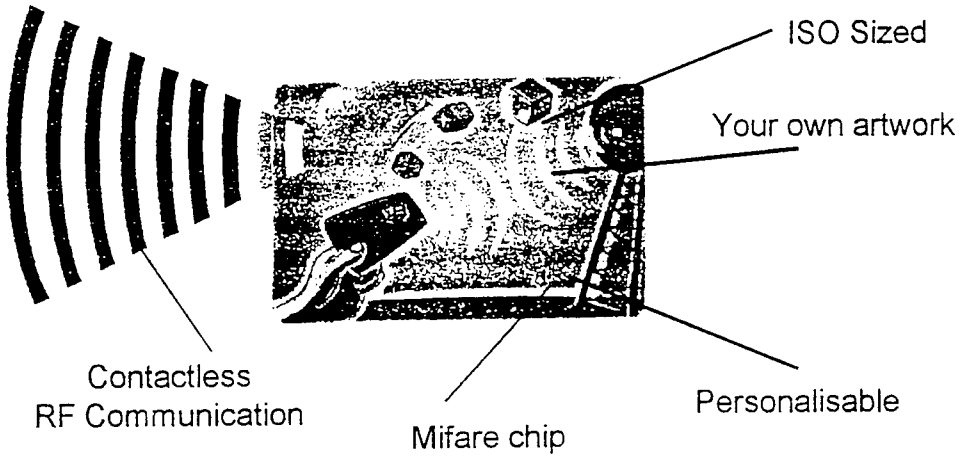
	Speed	Inter modality	Flexibility	User Friendly	Life cycle cost	Accuracy	Security
Token	-	- -	- -	-	-	- -	- -
Paper	+	- -	- -	+	+ +	- -	- -
Paper mag stripe	+	-	-	+	-	-	-
Plastic mag stripe	+	+	+	+	-	-	-
Smart card contact	-	+ +	+	+	+	+ +	+ +
Smart card contactless	+ +	+ +	+ +	+ +	+ +	+ +	+ +

Comparison : Overall Costs

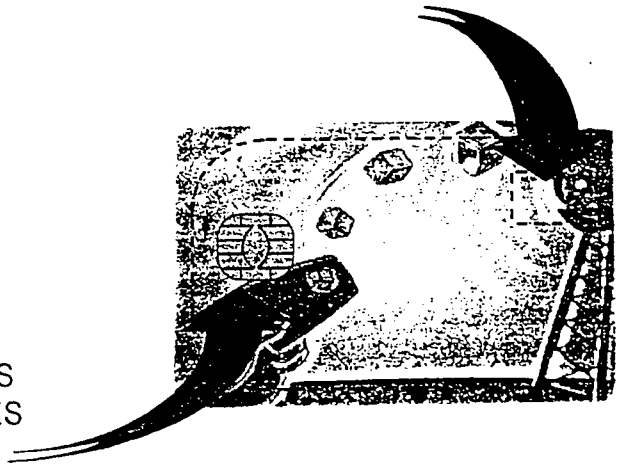
	Paper ticket	Magnetic Stripe	Smart Card (Contact)	Smart Card (Contactless)
Unit ticket cost (1 million units)	$0.01	$0.4	$3	$5/6
Number of transactions per ticket	1	2,000	10,000	50,000
Cost per transaction	0.01$	$0.0002	$0.0003	$0.00012
Ticket reliability	acceptable	low	high	high
Cost of reader	no reader	$2,000	$100	$150
Annual maintenance time/cost	n/a	20% / $400	15% / $15	5% / $8

Contactless Card system is globaly Cheaper

The Basis of our Offer



GemTwin GCL8K



MPCOS 8K-3DES
MPCOS 64K-3DES

Where ? Delivered In 95

Pilots & real size applications

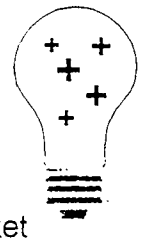
Main Projects Tomorrow...

and many more to come

TELETIC2 (553)

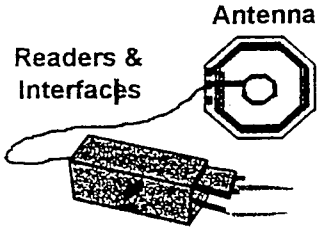
Contactless Cards because...

- User Friendly
- Speed
- Reliability
  - No moving part of the readers
  - No physical damage of the ticket
- Highly favorable life cycle cost
- Security : Smart card

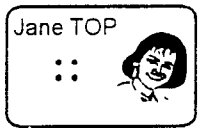


Because it's the best global & long term solution

GEMPLUS offer...



ContactLess Card

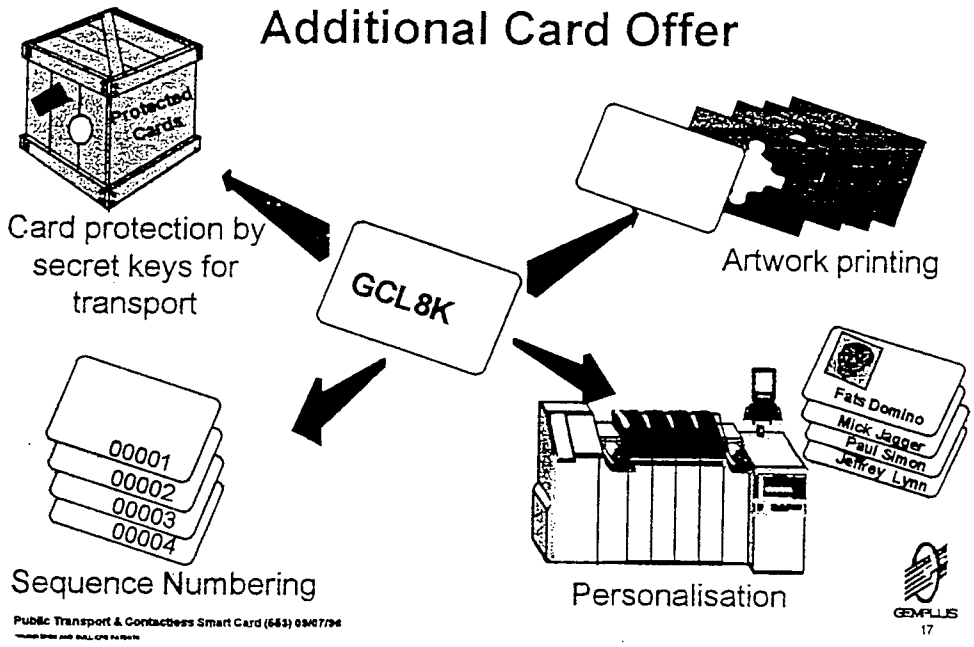


Personalization services

Training & Technical Support

Hybrid Card

Software : Drivers & Applications


Additional Card Offer
Protected Cards
Card protection by secret keys for transport
GCL8K
Artwork printing
00001
00002
00003
00004
Sequence Numbering
Fats Domino
Mick Jagger
Paul Simon
Jeffrey Lynn
Personalisation
GEMPLUS
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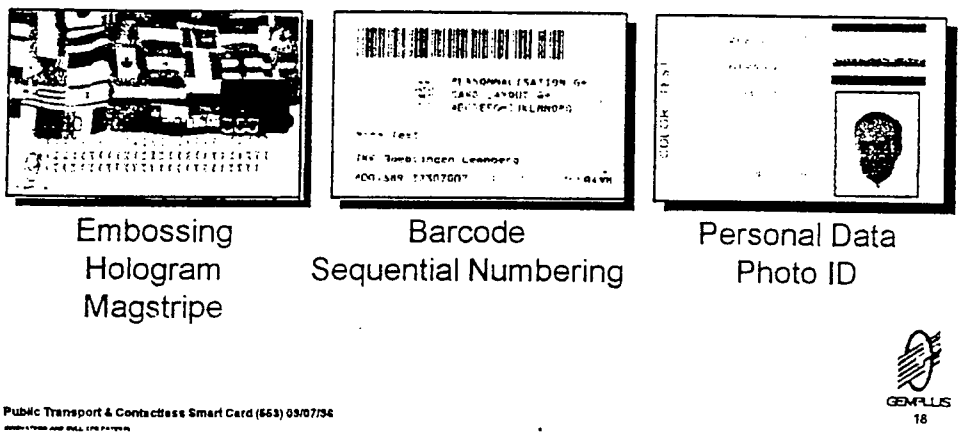
Personalisation examples
Embossing
Hologram
Magstripe
Barcode
Sequential Numbering
Personal Data
Photo ID
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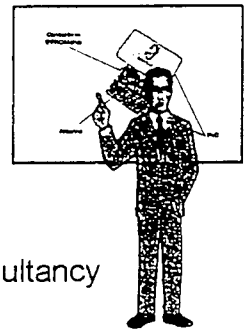
Additional Services

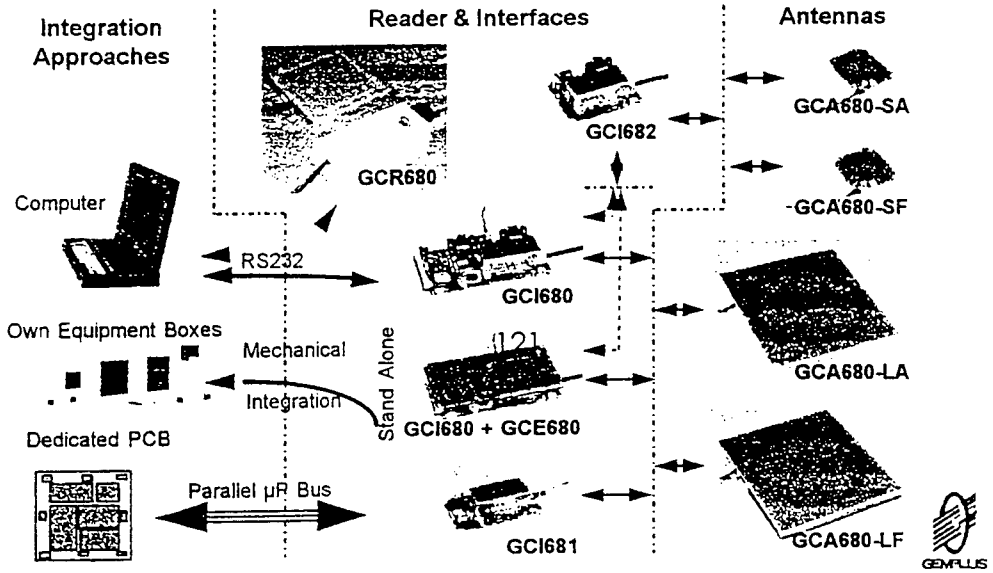
Training



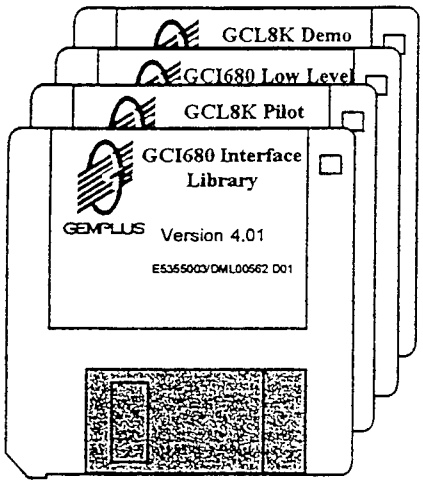
Consultancy

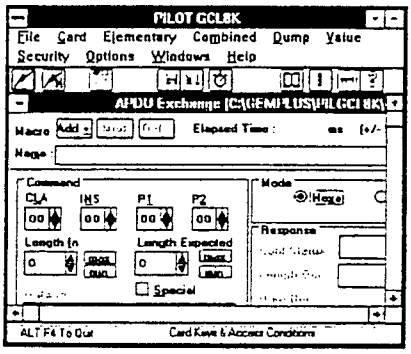
Hotline

Hardware Product Map for the GCL8K



Development Environment





Conclusion

Gemplus is world's N° 1 Producer of Contactless cards for public transport with a complete offer around a widely used and renowned technology

GEMPLUS

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