



Module 10: Electronic Fare Payment Systems

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Module Description

Fare collection systems are typically replaced in 7-15 year cycles and with each iteration agencies hope to upgrade to the most modern form of electronic fare payment system (EFPS) in order to provide their employees and passengers with the latest and most convenient forms of payment technology and services. Since most fare collection systems in the U.S. are currently based on the acceptance of coins, currency and paper tickets, however, the process of procuring an EFPS must begin with attaining an understanding of the options for technology and architecture and the steps that must be taken to select the option that will best meet the agency's objectives, budget, and operational requirements. This module provides an introduction to the complex subject of EFPS to help the participant develop that understanding.

1. Introduction/Purpose

Electronic Fare Payment is the automated calculation, validation, collection, recording, and reporting of passenger fare payments using some form of electronic media for rides on a mass transit system. The options available for electronic fare payment (EFP) systems have increased significantly over the last 20 years. However, for the majority of mass transit system operators in the U.S., paying for a ride on public transit still involves the use of non-electronic fare media including coins, flash passes, metal tokens, and paper transfers and tickets. These payment media offer few opportunities for automation and, as a result, provide minimal information to the agency on payments and ridership; require passengers to carry and use loose change in order to pay the exact fare, utilize manual, visual validation by vehicle operators, inspectors, and conductors, and are often inconvenient for passengers to acquire. Agencies universally embrace the need to adopt electronic fare payment systems that provide for more automated means of distribution and validation of fare media. This substantially improves the quantity and quality of payment and ridership data that is collected, and offers significant improvements in the convenience and ease of use for the passenger.

All transit agencies are motivated to periodically evaluate their existing fare collection methodology, equipment, and system in order to determine if conversion to some form of electronic fare payment (or an enhancement to, or replacement of an existing automated fare payment system) is required. Whether to identify the requirements for a replacement fare collection system to address the steadily increasing demands for better and more timely delivery of accurate ridership and fare payment data, or to fulfill the ongoing obligation to improve passenger convenience and promote use of mass transit, agencies must understand the features and benefits offered by the different forms of electronic fare payment systems. Today, such systems can be implemented to enable acceptance of magnetic stripe cards and tickets, contactless smart cards, and, where appropriate, could include fare payment using a mobile phone application or a bank-issued contactless debit or credit card.



This module provides an overview of the standards, technologies, and techniques associated with traditional as well as leading edge electronic fare payment systems and their associated benefits, risks, and issues in order to enable participants to understand and select the solutions that best meet the needs of a specific agency. It is not intended to be a comprehensive study on fare collection, fare collection systems or the procurement of electronic fare payment systems which are complex, multi-faceted subjects that are too broad to adequately address within the limited time allotted for this module.

2. Reference to Other Standards

Standard / Specification	Cost and Access Method	Website
APTA CFMS	Cost: No charge Access: Download from APTA website	http://www.apta.com/aptasearchcenter/results.aspx?k=utfs
EMV	Cost: No charge Access: Download from EMVCO website	http://www.emvco.com
ISO/IEC 7816	Cost: <\$50 Access: Download from ISO website	http://www.iso.org/iso/home.htm
ISO/IEC 8583	Cost: <\$225 Access: Download from ISO website	
ISO/IEC 14443	Cost: <\$50 Access: Download from ISO website	
ISO/TR 14806	Cost: <\$150 Access: Download from ISO website	
ISO/IEC 18092 (NFCIP-1)	Cost: <\$200 Access: Download from ISO website	
ISO/IEC 21481 (NFCIP-2)	Cost: <\$100 Access: Download from ISO website	
ISO 24014	Cost: <\$200 Access: Download from ISO website	
Payment Card Industry Data Security Standard	Cost: No charge Access: Download from PCI Security Council website	
Transit Communications Interface Profiles	Cost: No charge Access: Download from APTA TCIP website	http://www.aptatcip.com/Documents.htm



Other Standards and Specifications

Document(s)	Cost and Access Method	Website
American Express Expresspay	Cost: No charge after free registration on site Access: Download specifications from American Express Technical Specification website	https://www406.americanexpress.com/MTP/inter/UN/nsNavigateAction.do
Calypso	Cost: No charge Access: Register at Calypso Technical Support website	http://www.calypsostandard.net/index.php/access-request-form
CIPURSE	Cost: No charge with membership (no membership dues for transit agencies) Access: Documents available to OSPT Alliance members only.	http://www.osptalliance.org
Discover ZIP	Contact network for additional information	https://www.discover.com/credit-cards/help-center/account/zip/
ITSO	Cost: No charge Access: Download specifications from ITSO website	http://www.itso.org.uk
MasterCard PayPass	Cost: Paid license required Access: Download specifications from MasterCard PayPass website.	https://www.paypass.com/documentation.html
Visa payWave	Cost: Paid license required Access: Download specifications from Visa Technology Specifications website.	https://technologypartner.visa.com/Library/Specifications.aspx

3. Case Studies

Document(s)	Cost and Access Method	Website
<i>Hong Kong Octopus Card Profile</i>	Cost: No charge Access: Download from the Smart Card Alliance website.	http://www.smartcardalliance.org/publications-transportation/
<i>London Oyster Card Profile</i>	Cost: No charge Access: Download from	http://www.smartcardalliance.org/publications-transportation/



Document(s)	Cost and Access Method	Website
	the Smart Card Alliance website.	
<i>San Francisco Bay Area Translink Profile</i>	Cost: No charge Access: Download from the Smart Card Alliance website.	http://www.smartcardalliance.org/publications-transportation/
<i>Ventura County Transit Smart Card Profile</i>	Cost: No charge Access: Download from the Smart Card Alliance website.	http://www.smartcardalliance.org/publications-transportation/
<i>Washington Metropolitan Area Transit Authority (WMATA) – SmarTrip Profile</i>	Cost: No charge Access: Download from the Smart Card Alliance website.	http://www.smartcardalliance.org/publications-transportation/

4. Glossary

Term	Definition
Account-based System	Type of EFPS that utilizes a central system to: <ul style="list-style-type: none"> ▪ Manage accounts that store data critical for fare payment ▪ To receive and process fare payment requests from field devices ▪ To calculate the fare amount due ▪ To manage and analyze all fare payment data.
Card-based System	Type of EFPS where critical fare payment data is stored in digital form within the fare media and calculation of the fare amount due occurs on devices (e.g. station faregate, bus validator) at the points of entry
Closed Loop (Value)	An option for the use of monetary value in an EFPS where the value is usable only for payment of fares within a single transit agency system or by a group of transit agencies' that are cooperating in a regional fare payments program. With this option, value is purchased in advanced and the revenue associated with that purchase is owned and controlled by the agency or a regional clearinghouse operated by or on behalf of the participating transit agencies.
Contactless Bankcard	A credit, debit or prepaid debit card issued by a financial institution that uses contactless smart card technology to securely store card-specific data and transmit that data to other devices using radio waves. The specifications for communication protocol between card and reader vary by network (e.g. Visa, MasterCard, American Express, Discover).
Contactless Card	A credit card-sized plastic product with an embedded computer chip and antenna module capable of communicating with other devices over very short distances using radio waves. The

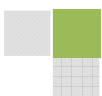
Term	Definition
	specifications for communicating with this type of card are governed by the ISO/IEC 14443 specification.
Depot Computer	A computer that resides in a bus depot and is used to collect fare payment data from the readers on board buses and to transmit that data to the central system. The depot computer may also be used to receive information from the central system, such as an update to the negative list, and to download that information to the readers.
Electronic Fare Payment Systems (EFPS)	System that performs automated calculation, collection, recording, and reporting of fare payment transactions for rides on a public transit system using some form of electronic validation and, in most instances, electronic media (e.g. contactless smart card, magnetic stripe card).
Farebox	A mechanical device installed in a bus or other public transportation vehicle for purposes of collecting, verifying and counting cash fare payments. Farebox components could include one or more integrated readers that enable it to interact with electronic payment media.
Farebox Probe	A device, such as a USB cable or wireless receiver/transmitter, that can communicate with a farebox to extract fare payment data and download updates to the farebox, such as changes to a negative list.
Fare By Distance	A type of fare policy structure where the fare varies depending on the distance travelled.
Farecard	Any type of payment media in the form of a paper or plastic card that can be used to make fare payments in an EFPS.
Faregate	A mechanical device in a station that acts as a barrier to prevent passengers without a paid fare from boarding a transit vehicle such as a ferry, subway, or train.
Fare Media	Term used to refer to any form of payment media (e.g. magnetic ticket, contactless smart card, limited use ticket) that can be used to pay a fare.
Fare Policy	The set of rules for a transit agency that define how, when, and by what methods passengers pay fares. A typical fare policy includes the base price of fares paid by cash or using stored value, the types and retail price of passes that can be purchased, the discounts on fares and passes offered to individuals and groups that qualify for participation in special fare programs, and the rules and cost for making transfers from one transit agency vehicle to another as part of a single journey.
Fare Product	The collection of passes and stored value that are offered by a transit agency to its passengers as a means to prepay for fares.



Term	Definition
Flat Fare	A type of fare policy structure where the fare is the same for each journey, regardless of the distance travelled. This is the most common type of fare structure.
Limited Use Ticket	A type of contactless card made from an inexpensive and disposable material such as paper, cardboard or a thin sheet of plastic. In most instances, limited use tickets are used once or for a short period of time (e.g. one day) and then are discarded. Like contactless cards, limited use tickets communicate via radio waves.
Magnetic Card, Magnetic Ticket	A small, often credit card-sized plastic or durable paper product with a magnetic stripe on one side that stores card-specific information in the form of magnetically encoded particles. Reading this information requires the media to be passed over a special reader “head” either by the passenger “swiping” the ticket or card through a reader or by inserting it into a device that has an electronic mechanism that pulls the media against a reader head.
Near Field Communications (NFC)	Term used to refer to a set of international standards for communication between devices using radio waves over short distances. The NFC standards have been widely employed by mobile device manufacturers to enable smartphones to send data to other smartphones without using the Internet and to other devices such as a merchant’s point of sale terminal to initiate a payment transaction.
Open Payment System	Type of EFPS where contactless bank-issued debit, credit, and/or prepaid debit cards are used as the exclusive fare media. This type of EFPS could be combined with either an account-based or card-based system.
Open Loop (Value)	An option for the use of monetary value in an EFPS where the value can be used to pay fares and to pay for goods and services at retail merchants. This type of value is associated with some form of bank-issued credit, debit, or prepaid debit card. The card issuer owns the account relationship and holds the credit line or deposits associated with the card and remits funds to the agency whenever those funds are used to pay a fare.
Pass	<p>A type of fare product that enables a passenger to prepay for either an unlimited number of rides within a predetermined period of time or to prepay for a distinct number of rides. Passes generally fall into three categories: Calendar-based, Time-based, and Trip-based.</p> <ul style="list-style-type: none"> ▪ Calendar-based: Provide unlimited rides during a specified period of dates and/or times (e.g. January 1 12:00 am through January 31, 11:59 pm) ▪ Time-based: Provide unlimited rides during a specified



Term	Definition
	<p>period of time (e.g. 30 days).</p> <ul style="list-style-type: none"> ▪ Trip-based: Provide a specific number of rides or “trips”
Quick Response (QR) Code	<p>The trademark for a type of matrix or two-dimensional, machine-readable code that consists of an array of squares that can represent as many as 1,264 alphanumeric characters. Those characters could be a unique identification number for the payment media, an account number, or any other information that is used by the EFPS to perform fare collection. A QR code could be printed on a paper ticket or it could be displayed on a mobile device. A QR code can be read using a camera (or other form of optical lens) or a laser scanner connected to a device with software capable of interpreting the codes.</p>
Retail Terminal / Ticket Office Machine	<p>A personal computer or comparable device used by a retail store or agency to support the sale of farecards and/or fare products to passengers. The Retail Terminal provides the means to communicate sales information to the central computer.</p>
Station Computer	<p>A personal computer or server that acts as the communications hub between the EFPS central computer and all of the passenger-facing devices (e.g. ticket vending machines, faregates) within a station.</p>
Stored Value	<p>Term used to describe electronic funds that can be used much like cash for payment of fares in an EFPS.</p>
System Architecture	<p>The set of all components (e.g. hardware, software, interfaces, and external systems) of an EFPS and the methods used to send information between those components.</p>
Tap In, Tap Out	<p>A type of EFPS where passengers are required to present their payment media upon boarding and when disembarking to enable the EFPS to determine the total distance or number of zones traveled and to calculate the fare based on that distance.</p>
Ticket Vending Machine (TVM)	<p>A device used by passengers to purchase fare products and, in some instances, farecards and limited use tickets for use in an EFPS. Ticket Vending Machines typically provide the means for passengers to use cash to make purchases but may also accept various forms of bankcards.</p>
Transaction Tearing	<p>Condition where, in the process of writing data to a contactless card, communications to the reader is lost, resulting in an incomplete set of data being written. In some instances, this can render the card inoperable.</p>
Transaction Time	<p>Term used to refer to the amount of time required to process a fare payment and to enable a passenger to board a vehicle or pass through a faregate. Although there are numerous definitions in use, this term typically refers to the time from the moment that the payment media is first recognized by a reader to the time when an approval or decline message is displayed to</p>



Term	Definition
	the passenger.
Transfers	The process of starting a journey on public transportation using one transit vehicle or mode and continuing that journey on a different vehicle or mode. Passengers' transfer rights and associated costs are determined by the transit agency's fare policy (e.g. Up to two free transfers within 60 minutes of paying a full fare) and validated and enforced by the EFPS.
Zone Fare	A type of fare policy structure where fares are determined based on the number of zones that are crossed as part of a journey.

5. References

Other Standards, Specifications, and Documents

Document(s)	Cost and Access Method	Website
<i>Transit and Open Payments: An Emerging Approach for Fare Collection</i>	Cost: No charge Access: Download from the Smart Card Alliance website.	http://www.smartcardalliance.org/publications-transportation/
<i>Planning for New Fare Payment and Collection Systems: Cost Considerations and Procurement Guidelines</i>	Cost: No charge Access: Download from the Smart Card Alliance website.	http://www.smartcardalliance.org/publications-transportation/
<i>Near Field Communication (NFC) and Transit: Applications, Technology and Implementation Considerations</i>	Cost: No charge Access: Download from the Smart Card Alliance website.	http://www.smartcardalliance.org/publications-transportation/
<i>Transit Payment System Security</i>	Cost: No charge Access: Download from the Smart Card Alliance website.	http://www.smartcardalliance.org/publications-transportation/
<i>Transit and Contactless Open Payments: An Emerging Approach for Fare Collection</i>	Cost: No charge Access: Download from the Smart Card Alliance website.	http://www.smartcardalliance.org/publications-transportation/



6. Study Questions

- 1. Which of the following is a feature of only an account-based EFPS?**
 - a) The central computer sends a negative list to each reader
 - b) Data stored on card is read and updated by the reader
 - c) Contactless bankcards are the primary fare media
 - d) The central computer is responsible for fare calculation

- 2. Which of the following EFPS features does the Transit Communications Interface Protocol (TCIP) cover?**
 - a) Local device to central computer message structure
 - b) Card data structure
 - c) Card to reader communication protocol
 - d) Physical requirements for contactless farecard

- 3. Which type of EFPS only supports value-based fares?**
 - a) Card-based EFPS
 - b) Open Payments EFPS
 - c) Account-based EFPS
 - d) All of the above

- 4. Which of the following is an important consideration when defining security requirements for an EFPS?**
 - a) Sensitive data protection
 - b) Protection of cash while being transported to a bank
 - c) On-board surveillance systems for bus vehicles
 - d) Scheduling of daily fare payment reports

