



Automatic Fare Collection System Planning and Implementation Guidelines

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Prepared by the APTA Operations Committee of the Universal Transit Fare System
(UTFS) Task Force

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1.0 UNIVERSAL TRANSIT FARECARD STANDARDS PROGRAM

This document is provided as part of the APTA Universal Transit Farecard Standards (UTFS) program, as an element of the work plan of the UTFS Operations Committee.

1.1 UTFS Program Purpose and Mission

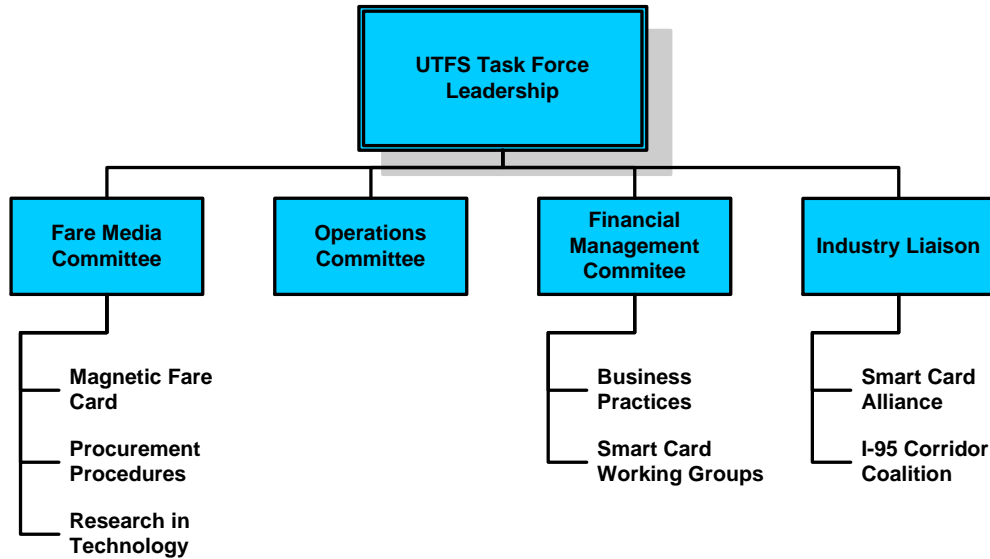
APTA created the UTFS Task Force with the following purpose and mission:

UTFS Purpose
"To facilitate the process for the transit industry to develop revenue management standards, recommend practices and guidelines, as appropriate, through a broad-based consensus process." ¹
UTFS Mission
"To develop a series of documents that provides industry guidance for the creation of an open architecture payment environment that promotes greater access and convenience to the public transportation network and enables integration of independent payment systems."

The UTFS Task Force is composed of individual volunteers from diverse organizations in the fare collection industry, including public agencies, consultants and suppliers. The task force itself has three standing committees - Fare Media, Financial Management and Operations - and industry liaison representatives, who are members of other organizations with similar objectives. An organization chart of the task force is shown on the following page.

¹ 1 APTA Universal Transit Farecard Standards Task Force, "Preamble", Task Force Bylaws, September 12, 2003

UTFS Organization Chart



1.2 Operations Committee Work Plan

The goals and objectives of the Operations Committee are to support the UTFS Standards Program by identifying and defining, from an operations perspective, critical elements essential to the implementation of an Automated Fare Collection (AFC) system.

The Committee Work Plan focuses on producing a set of documents (e.g., guideline specifications and recommended practices) for agencies to use in planning, designing, procuring, implementing and maintaining a local and/or regional AFC system. This document is intended to aid transportation decision-makers in taking the necessary steps to successfully plan for and invest in determining how to effectively invest in a fare collection system and an AFC system.

In producing the necessary decision-making tools for management, the Committee will ensure that work products provide direction to foster regional coordination and interoperability whereby agencies may also maintain their autonomy; and address the needs and requirements of small and large transit agencies.

The Committee has identified nine critical tasks essential to AFC system implementation. The nine tasks are identified in the table on the following page. The four tasks addressed in this document, prepared by LTK Engineering Services under direction by the Operations Committee, are highlighted in italics.

UTFS Operations Committee Work Plan	
Task	Task Description
1	<u>AFC Model to Plan, Design, Procure, Implement and Maintain a Local/Regional AFC System:</u> Producing a decision-making tool for planning and implementing a successful AFC program
2	<u>AFC Strategic Business Plan:</u> <i>Providing guidance in investigating and developing a business case for investment in a new AFC system.</i>
3	<u>Examination of Needs:</u> <i>Supporting an assessment of the existing system to determine its current condition and ability to meet future needs.</i>
4	<u>Funding:</u> Creating a checklist of items and examples on financial support (innovative financing) by the transit system, federal and local governments.
5	<u>Equipment Review:</u> <i>Providing guidance in a review process that supports a transition to interoperable transit systems and an integration of independent equipment systems</i>
6	<u>Preparation of Specification:</u> Creating a checklist of items and examples of how to design high-quality specifications for new equipment.
7	<u>Procurement:</u> Creating a checklist of items and examples for a high-quality procurement process and document
8	<u>Implementation of New Equipment and Related Process:</u> <i>Providing guidance in preparing and executing a plan for implementing an AFC system</i>
9	<u>Maintenance of Equipment:</u> Creating a checklist of items and examples for the day-to-day maintenance of equipment

2.0 TASK 2 - AFC STRATEGIC BUSINESS PLAN

2.1 Purpose and Scope

The guidelines provided in this section focus on providing a straightforward and concise means of building a business case for investing in the system. They provide a methodical approach for identifying and justifying the fare collection system that will best meet the objectives of the agency. This work is a product of Task 2 – AFC Strategic Business Case – of the work plan of the UTFS Operations Committee.

The guidelines are intended to be of value to an agency of any size for a fare collection procurement of any complexity. It does not focus on fare collection systems of any particular type of technology. It does, however, identify the technologies that are available for consideration. Some aspects of the guidelines may differ by agency. Each agency should adapt the approach to meet its specific needs.

The emphasis is on providing easy-to use guidance, with decision trees and checklists, with explanatory text as appropriate, and to illustrate their use, case studies of the approaches and experiences of transit agencies or regions having undertaken investment in a new or upgraded AFC system.

An overview of the strategic planning process is first provided. The user is then taken through each step in the process. In each case, tables or checklists are provided with narrative text to guide the user, with a flow chart illustrating the overall approach to system development. The flowchart is accompanied by supporting tables, checklists, illustrative examples and explanatory text as appropriate.

The approach that is outlined herein is based upon those methods that have been applied in several cases in which agencies have invested in new fare collection systems. An excellent source of information on system planning, with a number of case studies, is TCRP Report 94: Fare Policies, Structures and Technologies: Update, published by the Transit Cooperative Research Program of the Transportation Research Board (2003)

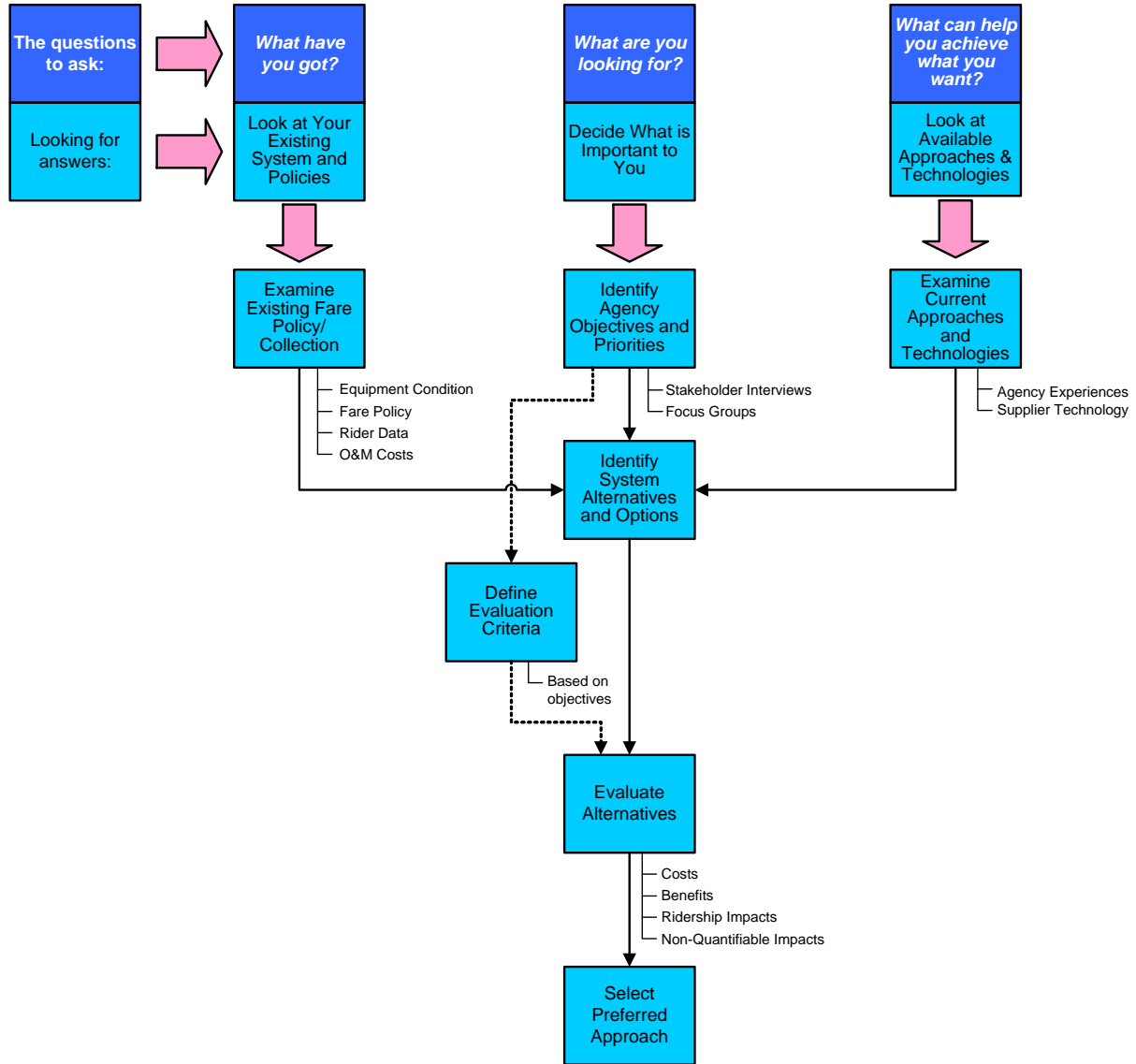
2.2 Strategic Planning Overview

The primary rule in developing a strategic plan for investment in a fare collection system is: never let technology dictate an agency's objectives. With rare exception, a transit agency must consider its needs within the context of real funding limitations. An objectives-oriented approach will help to "justify the bang for the buck". Proceed in the following manner:

Strategic Planning Overview	
1.	<u>Identify Objectives and Priorities:</u> Always start first with what the agency is hoping to achieve, and what is most important.
2.	<u>Examine the Existing Policy and System:</u> Take a close look at how the system currently in place is functioning and the extent to which it is meeting agency objectives.
3.	<u>Review Available Approaches and Technologies:</u> With an understanding of agency objectives and the existing system performance, examine available technologies for opportunities to better meet the objectives
4.	<u>Identify Alternative Solutions:</u> Develop alternative strategies for achieving the agency objectives, applying available approaches in both technology and fare policy.
5.	<u>Evaluate the Alternatives:</u> Base the evaluation on criteria that reflect the agency priorities.
6.	<u>Recommend the Preferred Approach:</u> This selected alternative should be the one that will most help the agency achieve its objectives.

This approach is shown in the flowchart – "Business Case Development for Investing in a New Fare Collection System" - on the following page. Following this approach should result in the agency procuring a system that effectively meets its needs, and in a manner that provides a necessary justification of investment in the system. Each step in the process is discussed further in the following sections.

Business Case Development for Investing in a New Fare Collection System



2.3 Identifying Objectives and Priorities

Identifying objectives and priorities is an important first step and requires a careful consideration of the issues that are important to all stakeholders in the system. Management interviews are the standard means of determining departmental priorities within the agency. Typically, interviews of each department with a role in fare collection activities or output reveals a different lesson and a unique set of priorities. Different priorities among departments may conflict. These conflicts may be resolved in interdepartmental meetings or at the executive level, or they may be carried forward in the development of alternative approaches that place greater emphasis on one set of priorities over another.

Understanding what is important to management is a critical part of identifying objectives and priorities. Interviews of system users can also highlight the strengths and weaknesses of the existing system and user preferences regarding a new one. Focus group interviews are an excellent means of determining priorities in this regard. In general, two “user” groups should be interviewed in focus groups: the personnel that must operate the system and the transit riders who must use it to pay their fare. Typically, operations and maintenance personnel can give first hand experience of both systemic issues and hardware issues. Regular and infrequent riders can give additional insights on system design and fare policy, helping to formulate approaches that will improve operations and ease of use.

It is valuable to keep in mind that the fare collection system is a means of achieving the agencies overall mission. Thus it is beneficial - and appropriate when justifying the system investment - to think first of the agency’s goals and objectives and then to relate the objectives of the fare collection system itself to these agency goals. The objectives and priorities of an agency will be unique to that agency, although there are general themes that are common among most operators.

The table on the following page – “Identifying Objectives and Priorities” - is provided as guidance in developing an agency’s own set of objectives and priorities. The left column identifies a set of agency goals and associated agency objectives. These goals are oriented around the business of providing transit service: Increase revenue, Increase ridership, Decrease cost. More specific objectives can be identified pertaining to each goal. Thus, for the goal of increasing revenue, objectives may include: generating more revenue per rider and stemming losses of revenue from theft, counterfeiting, alteration and non-payment. Objectives focusing on increasing ridership may include: improving service quality, improving ease of use, learning more about ridership characteristics and creating new markets for transit.

Objectives that focus on how the fare collection system needs to support the agency in attaining its goals and objectives are then identified. In our sample set of objectives, the fare collection objectives are shown in the right column. Thus, an agency goal of increasing ridership and the associated objective of pricing services to reflect the value of the service would support a fare collection system objective of ensuring the system is designed with the flexibility to introduce these new pricing schemes. Similarly, an agency objective of improving service quality by improving travel times is associated with a system objective of introducing a fare system that reduces or eliminates the time to collect fares when boarding at each stop or station.

As a public agency providing a public service, a transit agency also follows certain mandates and social objectives. The mandates include: meeting established regulations regarding accessibility, reduced fares for seniors and physically-challenged users, reporting requirements, and in some cases, subsidy caps and interagency coordination of service and fares. Social objectives may include maintaining fare equity in fare structure and fare pricing. System design will need to be consistent with the mandated requirements.

Identifying Objectives and Priorities	
Agency Goals / Objectives	Fare Collection System Objectives
Increase Revenue	
<ul style="list-style-type: none"> • Generate more revenue from riders Change fare policy to increase revenue per rider 	<ul style="list-style-type: none"> • Flexibility Provide the ability to accommodate new fares and adjustments to fares
<ul style="list-style-type: none"> • Collect the correct fare from each rider 	<ul style="list-style-type: none"> • Enforcement Ensure that all riders pay the fare; deter non-payment Ensure that miscalculation will not collect the wrong fare. Prevent improper sharing or re-use of fare media Prevent improper use of expired fare media
<ul style="list-style-type: none"> • Decrease loss of revenue from theft 	<ul style="list-style-type: none"> • Revenue Security Ensure that all cash revenue is secure from collection to processing and deposit Ensure that fare media is secure from public and internal theft Deter altering or counterfeiting of fare media
Increase Ridership	
<ul style="list-style-type: none"> • Improve Service Value Provide fares that match perceived value of service provided 	<ul style="list-style-type: none"> • Flexibility As above, provide the ability to accommodate new fares and adjustments to fares
<ul style="list-style-type: none"> • Improve Service Quality Reduce Travel Times Provide reliable service Adjust or introduce service that best meets travel demand 	<ul style="list-style-type: none"> • Service Quality Reduce boarding times to speed average travel time Accommodate surge volumes at special events
<ul style="list-style-type: none"> • Improve Ease of Use Encourage system use by instilling confidence in how to use it 	<ul style="list-style-type: none"> • Data Quality Provide ridership characteristics on travel habits by time, location and fare type • Convenience Simplify fare media purchase methods Simplify fare payment methods
<ul style="list-style-type: none"> • Open new markets to transit use Market transit benefits program to employers Market partnerships with universities Create interagency agreements for interline fares 	<ul style="list-style-type: none"> • Versatility Simplify program administration to attract participants Integrate fare media and ID; provide accounting of student use for invoicing or payment Provide common fare media, provide accounting of rider use for payment reconciliation
Decrease costs	
<ul style="list-style-type: none"> • Reduce annual budgetary costs 	<ul style="list-style-type: none"> • Cost Efficiency - (Direct Annual Costs) Reduce cost of collecting fares, system maintenance, cash revenue collection and processing, fare system administration, and fare media • Cost Efficiency - (Indirect Annual Cost) Reduce dwell times at stops and stations Reduce reliance on manual counts and surveys for ridership data collection
<ul style="list-style-type: none"> • Invest limited available funds in new systems to maximize benefits 	<ul style="list-style-type: none"> • Cost Effectiveness - Capital Cost of Project Justify investment in new or upgraded system with demonstrated benefits; minimize the capital cost

2.4 Examining Existing Fare Policy and Fare Collection System

An examination of existing fare policy and the existing fare collection system provides a baseline from which to compare alternative approaches. It also provides an appreciation of agency objectives and priorities regarding fare policy and fare collection; the perceived shortcomings of the existing system influence priorities among the objectives.

Examination of policy and system will include the following:

- Fare policy
 - Fare categories
 - Service classifications
 - Rider classifications;
- Ridership characteristics
 - Ridership by fare type
 - Ridership by service
 - Travel characteristics
- Fare collection system
 - Current physical condition
 - Cost of operating, maintaining and administering the system.

Understanding fare policy and ridership characteristics will have a bearing on the extent to which certain alternative fare policy and fare collection approaches will succeed. For example, a high percentage of lower income transit dependent riders traveling to work may be unable to take advantage of discounted monthly passes due to the up-front cost of purchasing the farecard.

The current condition of the fare collection system will affect the agency's ability to meet its objectives in several ways. In addition to evaluating the current system based on the objectives, its age and physical condition will have a bearing on a decision to replace it. Issues related to system age may include the following:

- Maintenance Cost: Wear and tear of non-replaceable components of the equipment will incur higher maintenance costs with more frequent repair and necessitated overhaul.
- Reliability: Poor reliability of equipment can result in lost revenue when the equipment cannot accept cash or deduct a fare from a farecard. Lack of in-service TVMs at a station can compromise an entire proof-of-payment fare collection system.
- Lack of Parts: Exacerbating the maintenance problem may be a scarcity of replacement parts for discontinued items, and a business decision by the supplier to no longer support the equipment.
- Security: Older equipment may be less secure. Keys may have been lost, stolen or duplicated. Worn components may longer sufficiently secure revenue compartments.

Developing a baseline annual cost for the existing system forms a basis for comparison of all alternatives with each other and with the system in place. It also guides cost development in reflecting organization structure, job types, grade levels and burdened costs, which will be unique to each agency. Cost elements associated with collecting and processing fares are identified in the table – “Examining Existing Fare Policy and Fare Collection” - on the following page. The costs identified in the table are those directly associated with fare collection activity. In analyzing the potential of alternative fare collection approaches, certain indirect costs may become very important. For example, implementing a fare collection system that significantly speeds boarding and reduces dwell times can reduce the number of vehicles and operators required to provide a given level of service.

³A more detailed discussion of assessing the current condition of the existing system is provided in a separate task of the UTFS Operations Committee: Task 3 – Examination of Needs.

Examining Existing Fare Policy and Fare Collection	
Elements of the Cost of Fare Collection	
Direct Labor Costs	Direct Non-Labor Costs
Operations <ul style="list-style-type: none"> • In-station Fare Collection • Dedicated On-Vehicle Fare Collection 	Operations
Maintenance <ul style="list-style-type: none"> • Field Equipment Maintenance and Repair • Inventory Control • Maintenance Management • Revenue Processing Equipment Maintenance and Repair 	Maintenance <ul style="list-style-type: none"> • Shop Facilities Costs • Maintenance Vehicle Costs
Fare Media <ul style="list-style-type: none"> • Fare Media Purchase Inventory • Fare Media Sales and Refunds • Transit Benefits Program Promotion, Distribution and Control • Personal Farecard Distribution and Control (Smart Card) 	Fare Media <ul style="list-style-type: none"> • Fare Media (including waste – unused stock) • Storage Facility Costs • Fare Media Delivery Vehicle Costs • Commissions on Third-Party Sale of Farecards • Credit/Debit Card Processing Fees • Regional Clearinghouse Transaction and Customer Service Fees
Cash Revenue <ul style="list-style-type: none"> • Revenue Servicing and Collection from Station Equipment • Cash Processing and Deposit • Revenue Servicing of Station Equipment • Revenue Management 	Cash Revenue <ul style="list-style-type: none"> • Revenue Transport Vehicle Costs • Revenue Collection/Transport Contract Costs (if outsourced)
Fare Inspection <ul style="list-style-type: none"> • Fare Inspection in a Proof-of-Payment System • In-house Adjudication Board • Violation Processing and Tracking • Fare Inspection/Violation Processing Management 	Fare Inspection <ul style="list-style-type: none"> • Fare Inspection Contract Costs (if outsourced) • Fare Inspection Vehicle Costs • Fare Inspection Facility Costs
Police/Security <ul style="list-style-type: none"> • Revenue Collection Security • Revenue Processing Security 	Police/Security <ul style="list-style-type: none"> • Revenue Security Contract Costs (if outsourced)
Information Systems <ul style="list-style-type: none"> • System Software Administration and Maintenance Reports Development 	Information Systems <ul style="list-style-type: none"> • Software Licenses
In-Direct Labor Costs	
Operations <ul style="list-style-type: none"> • Additional Vehicle Operators required for Slower Vehicles • Supervisor Time Spent Troubleshooting Jammed Equipment 	

2.5 Understanding Potential Approaches and Available Technologies

The last 12-15 years have seen an explosion of applied technology in fare collection systems. This has included improvements in handling cash – bills and coins – reliably, securely and efficiently. It has included improvements to fare media: printed farecards are more secure with holograph foils, magnetic farecards can be reliably issued, read and re-encoded on vehicles as well as in station fare gates. Smart cards – farecards with embedded electronic memory (and sometimes, processing) chips – have the capacity to be configured in any of several ways, accommodating both the commuter and occasional rider and working reliably for up to five years.

Equipment advancements have made fare payment considerably easier, even with complex fare structures. The equipment is more reliable and revenue is more secure. Increased processing power and memory enables the equipment to record and communicate the details of each transaction at a farebox, ticket vending machine, fare gate or electronic farecard validator. Registering fareboxes separate bills and coins and provide a limited accounting of cashbox contents. New validating fareboxes act as mobile ticket vending machines, validating bills and coins by denomination for an accurate accounting of a transaction and providing the opportunity to add-value to electronic farecards and to issue “coin cards” as change.

Transit agency web sites now provide a convenient means of pre-purchasing farecards or adding value to existing cards. A patron can also set up automatic recurring “autoloads” of value on a personal (registered) smart card, so that the card never runs out of fare.

Although there are many options to each technology, the basic advanced technology approaches include systems based upon magnetic farecards, smart cards, or a combination of both. Each has its own advantages and disadvantages, its strengths and weaknesses. There are significant differences in capital and annual costs, fare policy flexibility, ease of use and security.

Other non-technical approaches are available for consideration in an evaluation of fare collection alternatives. Proof-of-payment fare collection uses the occasional, random manual inspections of fare media and severe monetary penalties for non-payment in place of the regular enforcement of fare payment by supervised fare gates and fareboxes. It is a low tech approach relying on visual inspection but which can accommodate electronic fare media using hand-held card readers which visually display encoded information.

Basic technologies and operating approaches are presented in the table – “Examining Fare Collection Approaches and Technologies” - on the following page. This table is not all-inclusive. It is intended to identify the basic approaches that can be applied for development of system alternatives.

Examining Fare Collection Approaches and Technologies	
System Approaches	Examples of Cities with This Technology
Fare Media	
Printed Tickets and Passes	<i>Most Transit Operators</i>
Tokens	<i>San Jose</i>
Magnetic Farecards <i>Read Only</i> <i>Read/Write</i>	<i>Seattle</i> <i>Las Vegas, Minneapolis, Houston</i>
Smart Card <i>Plastic Long/Life Reusable</i> <i>Paper Disposable</i>	<i>Chicago, Wash DC, Atlanta, LA</i> <i>Atlanta</i>
Fare Collection Methods	
On-Board <i>Manual Supervision with Farebox</i>	<i>Most Transit Operators</i>
Off-Board <i>Manual with Turnstiles</i> <i>Automated with Fare Gates</i> <i>Proof-of-Payment</i>	<i>Philadelphia, Cleveland</i> <i>BART, Wash DC, New York</i> <i>Portland, LA, Baltimore, Las Vegas</i>
Equipment Technology	
On-Board <i>Registering Farebox</i> <i>Validating Farebox</i> <i>Printed Ticket Issuer</i> <i>Magnetic Card Swipe Reader</i> <i>Mag Card Read/Encode/Issue Unit</i> <i>Smart Card Read/Encode Unit</i> <i>Smart Card Read/Encode/Issue Unit</i>	<i>Seattle, Dallas</i> <i>Montebello, Orange County, Wash DC</i> <i>Seattle</i> <i>Cleveland, Minneapolis, Houston</i> <i>Wash DC, Chicago</i> <i>Atlanta</i>
Off-Board <i>Printed Ticket Vending Machine</i> <i>Mag Card Ticket Vending Machines</i> <i>Printed Ticket Validator (Print)</i> <i>Smart Card Validator (Read/Encode)</i> <i>Credit/Debit Card Sales at TVMs</i> <i>Web-Site Sales and Directed Autoload</i>	<i>Portland, LA, LIRR, NJT</i> <i>Las Vegas, BART, Wash DC</i> <i>Portland, Caltrain</i> <i>Caltrain (Translink)</i> <i>Wash DC, Chicago</i> <i>Wash DC, Chicago</i>

2.6 Developing Solutions to Meet Agency Needs

Developing candidate solutions for consideration needs to be guided by the fare collection objectives identified in the earlier phases of the planning effort. The solutions are developed to meet the needs of the agency using different technologies and options. Thus, beginning with an understanding of the fare structure it wants to provide and the ridership markets that the agency wants to serve will help tailor the planning effort to those alternatives that will rate strongest in the evaluation.

Issues having the greatest impact on system definition include the following:

Identifying System Alternatives and Options	
Characteristics Influencing System Alternatives	
Types of Fares to be Offered Off-Board	<i>Examples:</i> <ul style="list-style-type: none"> • Fixed Period Passes (monthly, weekly) • Rolling Period Passes (30-day, 7-day) • Stored Value or Stored Ride
Types of Fares Available On-Board	<i>Examples:</i> <ul style="list-style-type: none"> • Single Ride • Cash Fare Transfers • All-Day Passes
Fare Structure	<i>Examples:</i> <ul style="list-style-type: none"> • Flat fare vs. Floating Zone vs. Mileage Based • Service Based: local, express, circulator
Ridership Characteristics	<ul style="list-style-type: none"> • Ridership by Fare Type • Ridership by Trip Characteristics: Single Boarding or Two-plus Boardings • Ridership by Service Type • Ridership by travel frequency: commuter, discretionary rider • Rider Demographics: Income Levels, Ability to pay Higher Value Fare, such as Monthly Pass, Likelihood of Using Autoloading Personal Smart Card
Service Characteristics	<i>Examples:</i> <ul style="list-style-type: none"> • Surface Transit – local buses, streetcar/light rail • Bus Rapid Transit • Rail Transit on Exclusive ROW with Station Stops

These characteristics define the basic approach to the system. Alternatives can then be laid out defining the fare media and equipment (on-board, off-board, remote), patron use of the system, and personnel responsibilities. Other issues to be defined may include the method and quality of data collection and the accommodation of offsite sales venues such as retail sales outlets, employer-oriented transit benefits programs and the transit agency web site.

One aspect of technology that becomes a key driver during development of the systems alternatives is the fare media technology. Key decisions to address as the system alternatives are defined include the use of printed passes and tickets, magnetic farecards or smart cards as the primary fare media. With the relatively high cost of disposable smart cards (see fare media cost comparison on the following page), those agencies wishing to continue issue of fare media on vehicles may opt to utilize both magnetic farecards and smart cards for different rider markets. Magnetic farecards are issued on the vehicles and for limited travel (day passes, transfers), while riders who prepay their fares may be encouraged to use a personal smart card.

With the expense of magnetic farecard encoding and issuing equipment - relative to smart card reader/encoders – some agencies are forgoing the issue of on-board farecards for any type of fare and are limiting linked trip fares to only those who have a personal smart card. In this case, cash fare riders will need to pay full fare for each boarding of a linked trip.

One question to address when considering the implementation of a smart card is the extent to which the personal reloadable smart card can be successfully distributed to all of the riders of the transit agency. Washington Metro in DC has been very successful in its campaign given the convenience of the card for the agency’s rail riders and the sole means now of receiving transfer privileges between bus and rail. Chicago on the other hand has had limited success in its early efforts in part because the smart card is duplicating the fare and transfer capabilities of the existing magnetic farecards.

Comparison of Fare Media Costs		
Farecard Type	Unit Price	Expected Life
Printed Passes, Tickets and Transfers		
Paper	1.2¢ – 1.5¢	Up to 1 month
Magnetic Farecards		
Plastic	8.2¢ - 20.7¢	1-3 months
Paper	2.5¢ - 6.1¢	Up to 1 month
Smart Cards		
Plastic Reloadable	\$1.00 - \$2.75	5 years
Paper Disposable	50¢ - 90¢	Up to 1 month

Any agency will of course define its own alternatives for evaluation according to its needs. The table – “Defining System Alternatives – An Illustration” - on the following pages is an illustration, showing the components of a description of system alternatives that might be considered by a transit agency. This illustration examines the alternatives of continuing a fare system relying on printed paper passes and tickets, or introducing one of the following: magnetic farecard system, a smart card system, or a system that uses both smart cards and magnetic farecards for specific purposes. As mentioned, it describes fare media, equipment, patron use and personnel duties, as well as how special programs would continue to operate, including data collection, sales outlets and transit benefits (employer pass distribution).

Defining System Alternatives - An Illustration				
	System Printed Passes and Transfers	System with Magnetic Farecards	System with Smart Cards	System with Magnetic and Smart Farecards
Bus Fare Collection Description	Bus system operates as it does today <ul style="list-style-type: none"> Onboard fare collection Front-door boarding only 	Bus system operates as it does today <ul style="list-style-type: none"> Onboard fare collection Front-door boarding only 	Bus system operates as it does today <ul style="list-style-type: none"> Onboard fare collection Front-door boarding only 	Bus system operates as it does today <ul style="list-style-type: none"> Onboard fare collection Front-door boarding only
Equipment on Buses	Located by the Driver at the Front Door <ul style="list-style-type: none"> Electronic Registering Farebox 	Located by the Driver at the Front Door <ul style="list-style-type: none"> Electronic Registering Farebox Magnetic Farecard Processor: reads, encodes inserted cards; Issues new cards Magnetic Farecard Swipe Reader: reads/verifies pre-purchased cards 	Located by the Driver at the Front Door <ul style="list-style-type: none"> Electronic Registering Farebox Smart Card Reader/Encoder 	Located by the Driver at the Front Door <ul style="list-style-type: none"> Electronic Registering Farebox Smart Card Reader/Encoder Magnetic Farecard Reader/Encoder
Fare Media	Paper Period Passes: <ul style="list-style-type: none"> Monthly and weekly passes sold at outlets and on web site and distributed via employers or via mail Paper Transfers and Day Passes: <ul style="list-style-type: none"> Issued by bus operator upon payment Paper Tickets: <ul style="list-style-type: none"> Sold in multi-trip books at outlets, schools, employers 	Paper Magnetic Farecards: <ul style="list-style-type: none"> Day passes issued by farebox, outlets 2-ride tickets issued by social service agencies and schools Plastic Magnetic Farecards: <ul style="list-style-type: none"> Multi-trip farecards purchased at TVMs and outlets Period passes (fixed and/or rolling period) purchased at TVMs and outlets Employee, student ID cards issued by agency and school or university 	Personal Smart Card: <ul style="list-style-type: none"> Issued and registered at customer service center. Distributed via employers, schools, other transit partners Add value (recharge) smart cards via TVMs, customer service centers, internet, POS units at retail outlets Disposable Smart Cards <ul style="list-style-type: none"> Issued by social services and schools pre-encoded for 1-, 2- or 10-trip use 	Personal Smart Card: <ul style="list-style-type: none"> Received and registered at customer service center Distributed via employers, schools, other transit partners Add value (recharge) Smart Cards via TVMs, customer service centers, internet, POS units at retail outlets Paper Magnetic Farecards: <ul style="list-style-type: none"> Day passes issued by farebox, outlets Issued by social service agencies and schools pre-encoded for 1-, 2- and 10-trip use
Patron Use	Payment: <ul style="list-style-type: none"> Purchase passes or ticket books at TVMs, outlets, mail or web site Pay cash fare at farebox for single-ride (one boarding), single-trip (receiving transfer) or day pass Validation: <ul style="list-style-type: none"> Show pass to driver Insert ticket into farebox 	Payment: <ul style="list-style-type: none"> Purchase magnetic multi-ride tickets or period passes at TVM or outlet Pay cash fare at farebox for single-ride or day pass, receive magnetic farecard for day pass Validation: <ul style="list-style-type: none"> Insert magnetic farecard into reader/issuer to: <ul style="list-style-type: none"> Initialize flex passes Deduct trips from multi-ride farecards Deduct fare from stored-value farecards Swipe farecard in reader/validator to: <ul style="list-style-type: none"> Validate period passes previously issued and initialized 	Payment: <ul style="list-style-type: none"> Receive and register personal smart cards from customer service center Add value (recharge) smart cards via TVMs, customer service center, internet, POS units at retail outlets Pay cash fare at farebox for single-ride Validation: <ul style="list-style-type: none"> Tag smart card to smart card reader/encoder to: <ul style="list-style-type: none"> Deduct trips or value for trip Validate period passes Recharge smart cards on autoload 	Payment: <ul style="list-style-type: none"> Receive and register reusable smart cards from customer service center Add value (recharge) smart cards via TVMs, customer service center, internet, POS units at retail outlets Pay cash fare at farebox for single-ride or day pass, receive magnetic farecard for day pass Validation: <ul style="list-style-type: none"> Tag smart card to smart card reader/encoder to: <ul style="list-style-type: none"> Deduct trips or value for trip Validate period passes Recharge smart cards on autoload Insert magnetic farecard day pass and multi-trip tickets into reader/encoder to validate for trip
Service Personnel Duties	Bus Operator: <ul style="list-style-type: none"> Visually verifies payment into farebox Visually verifies passes Registers fare type by keypad 	Bus Operator: <ul style="list-style-type: none"> Verifies fare inserted in farebox Supervises fare validation in swipe reader and reader/issuer Issues day passes from reader/issuer following fare payment Registers cash transactions via keypad 	Bus Operator: <ul style="list-style-type: none"> Verifies fare inserted in farebox Supervises fare validation in smart card reader/encoder Registers cash transactions via keypad 	Bus Operator: <ul style="list-style-type: none"> Verifies fare payment inserted in farebox Issues mag card day passes from reader/issuer after fare payment Supervises fare validation in smart card reader/encoder and magnetic farecard reader/encoder
Data Collection	<ul style="list-style-type: none"> Bus operator records each boarding transaction Checkers survey/observe riders on fare type 	<ul style="list-style-type: none"> Farebox, Reader/Encoder and Swipe Reader record each transaction; data can be tied to vehicle location via AVL/GPS TVMs record each sale of farecards 	<ul style="list-style-type: none"> Smart Card Reader/encoder records each transaction; data can be tied to vehicle location via AVL/GPS TVMs record each sale of farecards and each recharge of smart cards 	<ul style="list-style-type: none"> Magnetic Farecard Reader/Encoder and Smart Card Reader/encoder record each transaction; data can be tied to vehicle location via AVL/GPS TVMs record each sale of farecards and each recharge of smart cards

Defining System Alternatives - An Illustration				
	System Printed Passes and Transfers	System with Magnetic Farecards	System with Smart Cards	System with Magnetic and Smart Farecards
Fare Media Control	<ul style="list-style-type: none"> Purchase / store / distribute pre-printed passes, ticket books, transfers Supply buses with pre-printed transfers for on-board issue 	<ul style="list-style-type: none"> Purchase / store / distribute pre-printed / pre-encoded passes, transfers, and tickets Supply buses with mag card stock for on-board issue as transfers or day passes 	<ul style="list-style-type: none"> Purchase / store / encode / issue / register personal smart cards Maintain smart card database of transactions, reloads, lost/replaced cards, account linkages for automatic payment 	<ul style="list-style-type: none"> Purchase / store / encode / issue / register personal smart cards Supply buses with mag card stock for on-board issue as transfers or day passes Maintain smart card database of transactions, reloads, lost/replaced cards, account linkages for automatic payment
Revenue Administration	<p>Farebox Revenue:</p> <ul style="list-style-type: none"> Cash is emptied from cashboxes, counted and deposited Upload cash and transaction data <p>Fare Media Sales:</p> <ul style="list-style-type: none"> Credit to agency accounts sales of passes and ticket books at outlets, from TVMs and via web site 	<p>Farebox Revenue:</p> <ul style="list-style-type: none"> Cash is emptied from cashboxes, counted and deposited Upload cash and transaction data Download mag card bad card data <p>Fare Media Sales:</p> <ul style="list-style-type: none"> Credit to agency accounts sales of passes and ticket books at outlets, from TVMs and via web site 	<p>Farebox Revenue:</p> <ul style="list-style-type: none"> Cash is emptied from cashboxes, counted and deposited Upload cash and transaction data Download smart reload and bad card info <p>Fare Media Sales:</p> <ul style="list-style-type: none"> Update registered personal smart card database <ul style="list-style-type: none"> Reloads to smart cards Fare payments 	<p>Farebox Revenue:</p> <ul style="list-style-type: none"> Cash is emptied from cashboxes, counted and deposited Upload cash and transaction data Download smart card reload and bad card data <p>Fare Media Sales:</p> <ul style="list-style-type: none"> Update registered personal smart card database <ul style="list-style-type: none"> Reloads to smart cards Fare Payments
Sales Outlets	<ul style="list-style-type: none"> Sell pre-printed passes and multi-trip ticket books No equipment required 	<ul style="list-style-type: none"> Sell pre-encoded passes and tickets No equipment required 	<ul style="list-style-type: none"> Add value to personal smart cards Require reader/encoder units tied to point-of-sale terminal accepting cash or credit card. 	<ul style="list-style-type: none"> Add value to rechargeable smart cards Require reader/encoder units tied to point-of-sale terminal accepting cash or credit card
Transit Benefits Program	<ul style="list-style-type: none"> Receive requested quantities of pre-printed passes and ticket books No equipment required Corporate rep administers and distributes farecards 	<ul style="list-style-type: none"> Receive requested quantities of pre-encoded passes and tickets No equipment required Corporate rep administers and distributes farecards 	<ul style="list-style-type: none"> Electronic funds transfer into employee autoloading accounts is authorized by corp. rep Corp. rep issues smart card to new employees and ends EFT to terminated employees 	<ul style="list-style-type: none"> Electronic funds transfer into employee autoloading accounts is authorized by corp. rep Corp. rep issues smart card to new employees and ends EFT to terminated employees
System Options	<p>Read-only Magnetic Farecard:</p> <ul style="list-style-type: none"> Use mag card passes in place of paper passes Add swipe reader to farebox Riders swipe pass on bus Farebox records transaction; rejects bad cards <p>Tokens:</p> <ul style="list-style-type: none"> Sold in multiples of 5-, 10 or more Used in place of ticket books and multi-trip tickets. Recycled for resale 	<p>Validating Farebox:</p> <ul style="list-style-type: none"> Verifies/counts inserted bills, coins Rejects bad bills, coins Issues mag-card change card with cash overpayment <p>Account-Based Farecard:</p> <ul style="list-style-type: none"> Read-only mag-card read by swipe reader Farebox records transaction Fares paid are post-processed by withdrawing from a linked-bank account 	<p>Validating Farebox:</p> <ul style="list-style-type: none"> Verifies/counts inserted bills, coins Rejects bad bills, coins Allows on-board smart card reloads 	<p>Validating Farebox:</p> <ul style="list-style-type: none"> Verifies/counts inserted bills, coins Rejects bad bills, coins Allows on-board smart card reloads Issues mag-card change card with cash overpayment

2.7 Evaluating and Selecting from among the Alternatives

Evaluation of the identified alternatives applies criteria that are based upon the agency’s objectives and priorities. Many of the criteria may be subjective. Quantifiable objective criteria will include the capital cost of the system and the ongoing annual cost of operating, maintaining and administering the system. Application of emerging “cutting edge” technology warrants an assessment of the risk that not all desired results will be achieved. The table below – “Defining Evaluation Criteria” provides examples of commonly used objectives and evaluation criteria.

Defining Evaluation Criteria	
Objectives and Priorities are the Basis of the Evaluation Criteria – Examples	
<p>Objectives</p> <ul style="list-style-type: none"> • Flexibility • Fare Enforcement • Revenue Security • Service Quality • Data Quality • Convenience • Versatility • Cost Efficiency • Cost Effectiveness 	<p>Evaluation Criteria</p> <ul style="list-style-type: none"> • Flexibility • Fare Enforcement • Revenue Security • Service Quality • Data Quality • Convenience • Versatility • Cost Efficiency • Cost Effectiveness

Each alternative approach should be evaluated against the existing system. If preliminary evaluation indicates that the existing system may be capable of achieving most of the agency objectives with investment in overhaul or refurbishment, this should be included as an alternative.

Estimates of capital costs need to include all elements of a program to put the system in place. This includes the system and equipment itself, and in addition, the costs of agency, contractor and professional management and engineering for the program, and any third party costs that may be incurred to prepare for system integration with other systems or for installation in agency facilities and on agency vehicles.

The TRB report, “TCRP Report 94 – Fare Policy, Structures and Technologies”, provides information on cost ranges for capital and annual costs. The cost table – “Evaluating Capital and Annual Costs” - on page 20 of this document is reproduced from that report. It provides cost ranges for most types of fare vending and collection equipment in use today. The table also provides a means of estimating ongoing annual operating and maintenance costs for a fare collection system. Cost analyses applied to hypothetical transit agencies which are reproduced from TCRP Report 94 are provided as examples on pages 21 and 22 in two “Estimation of Costs” tables, one for a small bus agency considering smart cards and one for a bus/rail transit system considering magnetic farecards.

Capital and O&M costs are critical elements in an evaluation of alternatives but must also be considered with other objectives. Comparison tables enable the agency to compare the strengths and weaknesses of each alternative. The evaluation table - "Evaluation of Alternatives" – starting on page 23 was developed for the three alternatives identified in the table on pages 14-16. As described earlier, the criteria in a similar case reflected the objectives identified early in the project through interviews and focus groups. In our example, four subjective ratings were applied: poor, fair, good and very good. In addition a summary of key strengths and weaknesses are bulleted for each criterion, providing a means for participating staff and management to use their judgment when selecting the preferred alternative². Ultimately, this agency opted to procure a system that will continue use of the magnetic farecard system already in place and to be equipped to phase in the smart card at a timetable of its choosing. Although not applied in this case to select the preferred alternative, some agencies and consultants opt to score the alternatives by assigning weights (of priority or importance) to each objective and numeric values in place of subjective ones for the performance of each alternative against a criterion. Calculating numeric scores for each alternative can clearly identify the highest ranking alternative, although the process of weighting and scoring itself is a subjective process.

2.8 Selling the Plan

Fare collection systems typically represent a considerable investment in limited capital and need to demonstrate that its procurement and implementation will enable the agency to move forward in achieving its goals and objectives. Tracing the capabilities of the system back not just to the objectives of the fare collection system but to the goals and objectives of the agency itself will help to convince agency decision-makers of its ultimate value. Communication with executive management and often with one or more members of the Board can be critical to creating and maintaining support for the project. This enables top management and the Board to follow developments, act as a sounding board, provide guidance and direction as necessary and as the preferred system is selected, provide a champion to justify and promote investment in the system.

2.9 Closing

The objective of this document has been to provide guidance in establishing a business case for investing in a new fare collection system. It has described a process that focuses on defining and selecting a system and technology that best meets agency objectives and priorities. Approached in this fashion and with realistic expectations, the agency can avoid investing unnecessarily in a costly program when a most cost effective alternative is available. Identifying all direct and indirect costs associated with each alternative is critical to the evaluation; nor should those criteria that are not readily equated to a dollar value be ignored. A truly objective analysis and evaluation process will support justification of the proposed fare collection system when presented to the decision-makers who will approve investment in the program. In addition, winning early support of the process among these decision-makers – finding one or more champions among executive management or on the Board – will help develop the broad support needed among the entire Board.

² Other methods of illustrating subjective ratings include showing darkened quadrants in a circle, all-white being the lowest rating proceeding by one-quarter slices to a fully darkened circle for the highest rating: ○⇒...⇒◐⇒...⇒●

Evaluating the Alternatives: Estimating Capital and Annual Costs				
Cost Element	Cost (dollars)*		Nature of Cost	
	Low	High	One-Time	Ongoing
Bus-Related Costs per Unit				
Mechanical farebox	2,000	3,000	X	
Electronic registering farebox	4,000	5,000	X	
Electronic registering farebox (with smart card reader)	5,000	8,000	X	
Validating farebox (with magnetic card processing unit)	10,000	12,000	X	
Validating farebox (with smart card reader)	12,000	14,000	X	
Validating farebox (with magnetic & smart card reader)	13,000	17,500	X	
Stand-alone smart card processing unit	1,000	7,000	X	
Magnetic farecard processing unit (upgrade)	4,000	6,000	X	
Onboard probe equipment**	500	1,500	X	
Garage probe equipment**	2,500	3,500	X	
Application software (smart card units)	0	100,000	X	
Garage hardware/software	10,000	20,000	X	
Central hardware/software	25,000	75,000	X	
Rail-Related Costs per Unit				
Ticket vending machine (TVM)	30,000	60,000	X	
TVM upgrade—smart card processing	3,000	7,000	X	
TVM upgrade—magnetic farecard processing	3,000	5,000	X	
Add-Fare machine (cash only)	5,000	25,000	X	
Fare Gate (magnetic/contactless card)	20,000	35,000	X	
Stand-Alone smart card validator	5,000	8,000	X	
Stand-Alone magnetic farecard validator	8,000	11,000	X	
Portable (hand-held) smart card validator	2,000	4,000	X	
Attended smart card revaluing device	2,500	6,000	X	
Attended magnetic farecard issuing device	5,000	10,000	X	
Station hardware/software (heavy rail)	50,000	100,000	X	
Station hardware/software (light rail)	7,000	10,000	X	
Central hardware/software	100,000	200,000	X	
Variable System Costs				
Spare Parts (% of equipment cost)	10	15	X	
Support services include training, documentation, revenue testing, and warranties (% of equipment cost)	10	15	X	
Installation (% of equipment cost)	3	10	X	
Nonrecurring engineering & software costs (% of equipment cost)	0	30	X	
Contingency (% of equipment/operating cost)	10	15	X	X
Equipment maintenance costs (% of equipment cost)	5	7		X
Software licenses/system support (% of systems/software cost)	15	20		X
Revenue handling costs (% of annual cash revenue)	5	10		X
Clearinghouse (e.g., card distribution, revenue allocation) ++ (%of annual Automatic Fare Collection revenue) (% of annual AFC revenue)	3	6		X
Fare Media Costs per Unit				
Magnetic or capacitive cards	0.01	0.30		X
Contactless cards (plastic)	2.00	5.00		X
Contactless cards (paper)	0.30	1.00		X
Contact cards	1.50	4.00		X
Dual interface cards	5.00	10.00		X

Source: Transit Cooperative Research Program, TCRP Report 94, Fare Policies, Structures and Technologies: Update, Wash., D.C. 2003

Evaluating the Alternatives: Estimation of Costs – Smart Card Alternative for a Small Bus Property					
Cost Element	Unit Cost		Number of Units	Total Cost	
	Low	High		Low	High
<i>One-Time Costs</i>					
electronic farebox with smart card reader	\$8,000	\$109,000	100	\$500,000	\$800,000
smart card application software**	\$10,000	\$25,000	1	\$10,000	\$25,000
revenue equipment (vaults, bins, etc.)	\$40,000	\$65,000	1	\$40,000	\$65,000
garage hardware/software	\$15,000	\$35,000	2	\$30,000	\$70,000
attended smart card revaluing device***	\$2,500	\$6,000	5	\$12,500	\$30,000
spare parts	10% of equipment cost	15% of equipment cost		\$59,250	\$148,500
support services	10% of equipment cost	15% of equipment cost		\$59,250	\$148,500
installation/nonrecurring engineering	3% of equipment cost	10% of equipment cost		\$17,775	\$99,000
fare media costs (contactless cards) +	\$2.00	\$5.00	10,000	\$20,000	\$50,000
contingency costs	10% of one-time cost	15% of one-time cost		\$74,878	\$215,400
<i>Total One-Time Costs</i>				\$823,653	\$1,651,400
<i>Ongoing Costs</i>					
equipment maintenance costs	5% of equipment cost	6% of equipment cost		\$29,625	\$59,400
software licenses/system support	15% systems/software	20% systems/software		\$3,750	\$15,000
revenue handling costs (cash)	5% of cash revenue	10% of cash revenue		\$120,000	\$240,000
clearinghouse costs++	3% of smart card revenue	6% of smart card revenue		\$72,000	\$144,000
contingency costs	10% of ongoing cost	15% of ongoing cost		\$22,538	\$68,760
<i>Total Ongoing Costs</i>				\$247,913	\$527,160
Total First Year Cost				\$1,071,565	\$2,178,560

Source: Transit Cooperative Research Program, TCRP Report 94, Fare Policies, Structures and Technologies: Update, Wash., D.C. 2003

Evaluating the Alternatives: Estimation of Costs – Magnetic Card Program for a Bus/LRT Agency					
Cost Element	Unit Cost		Number of Units	Total Cost	
	Low	High		Low	High
<i>One-Time Costs</i>					
validating farebox with card processing unit	\$10,000	\$12,000	800	\$8,000,000	\$9,600,000
revenue equipment (vaults, bins, etc.)	\$40,000	\$65,000	1	\$40,000	\$65,000
garage hardware/software	\$15,000	\$35,000	4	\$60,000	\$140,000
farecard vending machine **	\$35,000	\$60,000	40	\$1,400,000	\$2,400,000
card TVM interface upgrade	\$3,000	\$5,000	40	\$120,000	\$200,000
station hardware/software	\$7,000	\$10,000	20	\$140,000	\$200,000
spare parts	10% of equipment cost	15% of equipment cost		\$976,000	\$1,260,500
support services	10% of equipment cost	15% of equipment cost		\$976,000	\$1,260,500
installation/nonrecurring engineering	3% of equipment cost	10% of equipment cost		\$292,800	\$378,150
fare media costs (magnetic farecards) +	\$0.05	\$0.25	180,000	\$9,000	\$45,000
contingency costs	10% of one-time cost	15% of one-time cost		\$1,201,380	\$2,332,373
<i>Total One-Time Costs</i>				\$13,215,180	\$17,881,523
<i>Ongoing Costs</i>					
equipment maintenance costs	6% of equipment cost	7% of equipment cost		\$585,600	\$882,350
software licenses/system support	15% systems/software	20% systems/software		\$51,000	\$135,000
revenue handling costs (cash)	5% of cash revenue	6% of cash revenue		\$1,500,000	\$3,000,000
revenue handling costs (farecards)	3% of farecard revenue	10% of farecard revenue		\$900,000	\$1,800,000
contingency costs	10% of ongoing cost	15% of ongoing cost		\$303,660	\$872,603
<i>Total Ongoing Costs</i>				\$3,340,260	\$6,689,953
<i>Total First Year Cost</i>				\$16,555,440	\$24,571,475

Source: Transit Cooperative Research Program, TCRP Report 94, Fare Policies, Structures and Technologies: Update, Wash., D.C. 2003

Evaluation of Alternatives – An Illustration				
Evaluation Criteria	System Alternatives			
	1. Printed Passes and Transfers	2. Magnetic Farecard	3. Smart Card	4. Smart Card & Magnetic Farecard
Capital Cost	Very Good <ul style="list-style-type: none"> Low cost fare media Minimal hardware 	Good <ul style="list-style-type: none"> Low cost fare media High cost hardware 	Good <ul style="list-style-type: none"> High initial fare media cost; Cost of back office and customer service network for adding value to smart card; Low cost hardware 	Fair <ul style="list-style-type: none"> High cost back office and customer service network for adding value to smart card; High cost of hardware for dispensing mag card
Operating and Maintenance Costs	Good <ul style="list-style-type: none"> Low cost of fare media Cost of unused fare media waste Low cost of maintenance Cost of media distribution and outlet fees 	Good <ul style="list-style-type: none"> Low cost of farecard media Relatively high cost of equipment maintenance 	Good <ul style="list-style-type: none"> High cost of disposable farecard media Back office and customer service network administration costs Low cost of equipment maintenance Reduced fare media distribution costs 	Fair <ul style="list-style-type: none"> Low cost of disposable farecard media; High cost of equipment maintenance Back office and customer service network administration costs Reduced fare media distribution costs
Fare Flexibility	Fair <ul style="list-style-type: none"> Passes and tickets are limited to a particular fare; more passes and tickets are needed for increasing complexity 	Good <ul style="list-style-type: none"> Ability to implement new fare types Electronics aids administration of fares over manual collection 	Good <ul style="list-style-type: none"> Greater processing capacity improves administration of complex fares Degree of success dependent on %riders using smart card 	Very Good <ul style="list-style-type: none"> Availability of both card technologies expands fare types that can be readily implemented
Service Quality	Good <ul style="list-style-type: none"> Flash passes speed boarding Manual enforcement of complex fares can slow boarding 	Good <ul style="list-style-type: none"> Swipe reader speeds boarding; Mag card reader/encoder unit slows processing 	Good <ul style="list-style-type: none"> Smart card use speeds boarding; Riders without smart card must use cash, slowing boarding 	Very Good <ul style="list-style-type: none"> Smart card speeds boarding, Mag card reader/encoder expedites day pass issue.
Fare Enforcement	Fair <ul style="list-style-type: none"> Reliance on operator to collect proper fare – miscalculation or miscount possible Visual verification of farecard authenticity and validity by operator 	Very Good <ul style="list-style-type: none"> Equipment reads and verifies farecard authenticity and validity for ride Equipment deducts proper fare Printing on mag card provides second means of verification 	Very Good <ul style="list-style-type: none"> Equipment reads and verifies farecard authenticity and validity for ride Equipment deducts proper fare 	Very Good <ul style="list-style-type: none"> Equipment reads and verifies farecard authenticity and validity for ride Equipment deducts proper fare Printing on mag card provides second means of verification
Convenience	Fair <ul style="list-style-type: none"> Passes and tickets are available from outlets, mail and TVMs Different passes or tickets must be purchased for each type of fare, limiting use to specific trips 	Good <ul style="list-style-type: none"> Readily accommodates pre-paid fares and onboard purchase of day pass 	Good <ul style="list-style-type: none"> Readily accommodates pre-paid fares and automatic determination of fares Automatic reloading ensures card never expires Conveniences are limited to personal smart cardholder 	Very Good <ul style="list-style-type: none"> Readily accommodates pre-paid fares and onboard purchase of day pass Automatic reloading ensures card never expires Mag card provides convenience for riders without smart card
Revenue Security	Poor <ul style="list-style-type: none"> Printed passes can be counterfeited or altered most easily of fare types; design countermeasures can reduce risk Printed transfer subject to theft from bus and resale 	Good <ul style="list-style-type: none"> An improvement over printed media, magnetic encoding can be altered and corrupted more readily than on smart card; Printing can corroborate encoding. 	Very Good <ul style="list-style-type: none"> Smart card encoding less open to alteration; Greater confidence in system; No printing to corroborate encoding Can hotlist lost smart cards that have been registered 	Very Good <ul style="list-style-type: none"> Smart card encoding less open to alteration; Greater confidence in system; Printing on day pass can corroborate encoding Can hot list lost smart cards that have been registered
Reliability	Very Good <ul style="list-style-type: none"> No equipment required to process printed media 	Good <ul style="list-style-type: none"> Mag card reader/encoder requires relatively high maintenance. Mag card swipe reader is low maintenance and reliable 	Very Good <ul style="list-style-type: none"> Solid state validator is very reliable. 	Good <ul style="list-style-type: none"> Mag card reader/encoder requires relatively high maintenance; Smart card validator is solid state and highly reliable
Versatility	Fair <ul style="list-style-type: none"> Printed passes support multi-purpose use for some read-only purposes 	Fair <ul style="list-style-type: none"> Mag card supports multi-purpose use for read-only purposes due to limited memory and processing capacity Post-processing of fare is possible using mag ID card 	Very Good <ul style="list-style-type: none"> Smart card supports multi-purpose use (universities, schools, social services, etc.) Smart card simplifies transit benefit programs; Full benefits rely on high %riders using smart card (frequent; occasional) 	Very Good <ul style="list-style-type: none"> Smart card supports multi-purpose use (universities, schools, social services, etc.) Smart card simplifies transit benefit programs Full benefit of program relies on distribution of smart card in large numbers Mag cards provide alternative for riders with limited need
Data Quality	Poor <ul style="list-style-type: none"> Reliance on bus operator and checkers to record 	Good <ul style="list-style-type: none"> Newer fareboxes record individual transaction data from each mag card to construct good rider detail. 	Very Good <ul style="list-style-type: none"> Smart cards provide information on linked travel and overall travel habits. Good data on riders without smart cards is difficult to collect 	Very Good <ul style="list-style-type: none"> Smart cards provide information on linked travel and overall travel habits Mag cards can be recorded and tracked for travelers without smart cards

3.0 TASK 3 - EXAMINATION OF NEEDS

3.1 Purpose and Scope

The guidelines presented in this task are provided to support agency examination of fare collection system needs, with an assessment of the state-of-repair of the agency's existing system and equipment. This work is a product of Task 3 – Examination of Needs – of the work plan of the UTFS Operations Committee.

The guidelines are intended to be of value to an agency of any size for a fare collection procurement of any complexity. They do not focus on fare collection systems of any particular type of technology. They do, however, identify the technologies that are available for consideration. Some aspects of the guidelines may differ by agency. Each agency should adapt the approach to meet its specific needs.

The section is organized to provide easy-to-use guidance, with a decision tree illustrating the overall approach to an assessment of system condition and a decision on replacement, modification, refurbishment or continued use. The flowchart is accompanied by supporting tables, checklists, illustrative examples and explanatory text as appropriate. These include checklists and tables for:

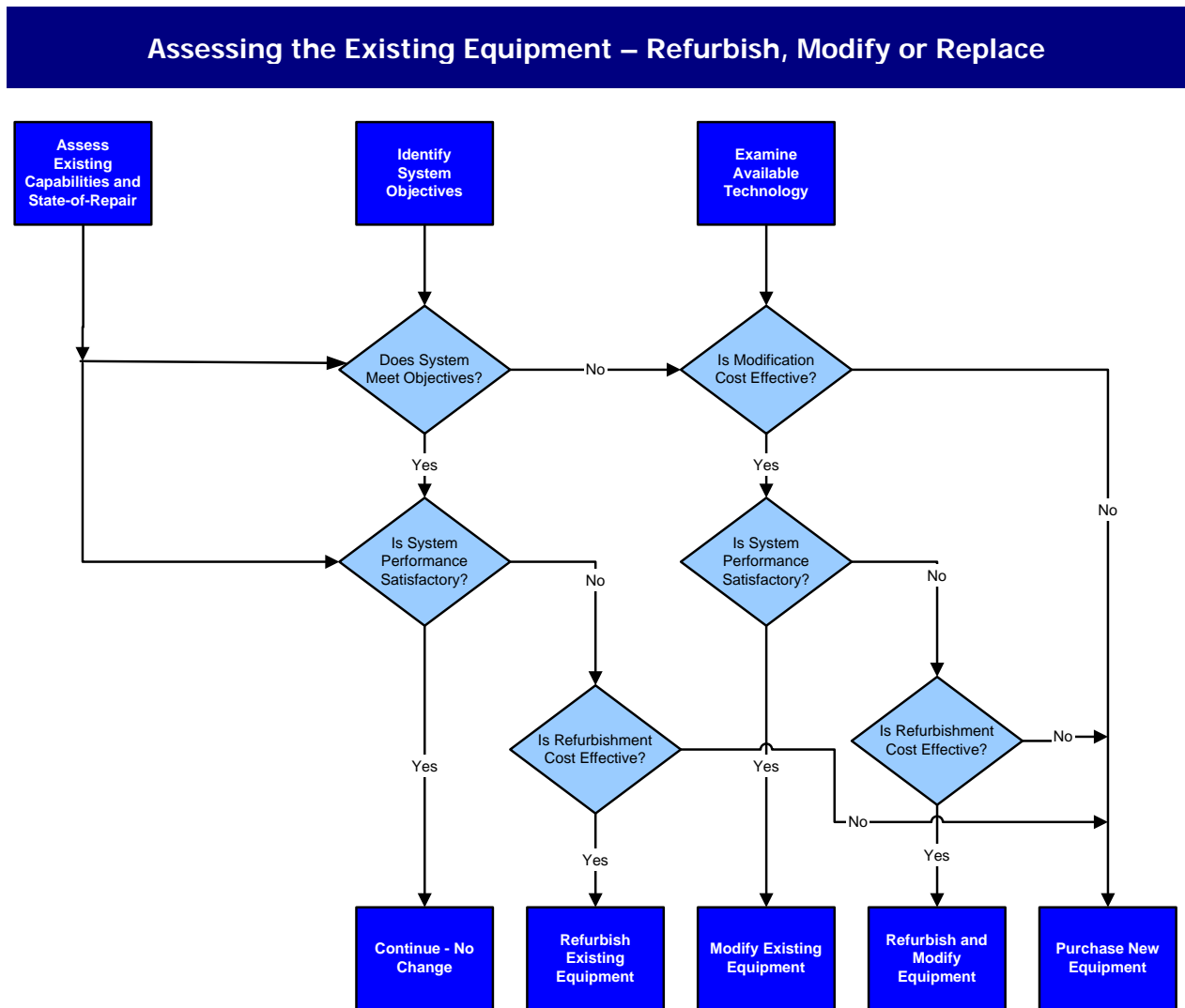
- Assessing System State-of-Repair
- Cost Elements of Refurbishment vs. Replacement
- Illustrations of Refurbishment and Modifications/Upgrades
- State-of-the-Art Technologies in Fare Vending and Fare Collection

These guidelines focus on providing a straightforward and concise means of assessing the state-of-repair of the equipment of an existing system in order to support any decision on replacement. The document also identifies the state-of-the-art in fare system technology to enable an agency to compare the capabilities of the existing equipment to the possibilities a new procurement might provide. It is intended to be of value to an agency of any size for a fare collection procurement of any complexity. The emphasis is on providing easy-to use guidance, with decision trees, tables, and checklists. The tables also provide examples of what some transit agencies have done to help the user in understanding a particular issue or approach.

3.2 Overview: Equipment Assessment as an Element of Fare System Strategic Planning

Development of a plan for addressing future fare system needs starts with three elements: Assessing what the agency has in place, defining what the agency wants to achieve, and knowing what means are available to meet these needs. An assessment of the existing system serves as a baseline against which to compare alternative systems. It also serves to determine whether the system does in fact require replacement to meet agency objectives. Less costly options may involve keeping the existing system, modifying it or refurbishing it. This task focuses on conducting an assessment of the existing system to determine its current state and whether it can be made to meet agency objectives.

The flow chart - below describes a general process for determination of whether a fare collection system should be refurbished, upgraded/modified, replaced, or left intact.



As the flowchart shows, a proper evaluation of system needs begins with three tasks: a definition of agency goals and objectives; an assessment of the existing systems capabilities and condition; and a good understanding of the alternative technologies and system approaches that are available. In other words, (1) define what you want to achieve, (2) determine if your existing system (equipment and policies) can help you achieve those goals, and (3) identify other potentially better approaches to achieving them.

The following matrix is another means of expressing the alternatives:

Deciding on System Disposition				
System Condition Satisfactory?	System Refurbishment Cost Effective?	Agency Objectives Achieved?	System Modification Cost Effective?	Best Approach
No	No			Buy New System
No	Yes	Yes		Refurbish System
No	Yes	No	Yes	Refurbish and Modify
No	Yes	No	No	Buy New System
Yes		Yes		Keep Existing System
Yes		No	Yes	Modify System
Yes		No	No	Buy New System

If the equipment is in poor condition and cannot be refurbished, then it will need replacement regardless of its ability to meet agency objectives. If the system can be refurbished but does not meet all agency needs, it may be possible to upgrade the system as it is refurbished. If not, then replacement may still be warranted. Even if refurbishment and/or modification is achievable, an analysis of the relative cost effectiveness of these approaches compared to a full replacement should be made as a basis of any investment decision. This involves an analysis of life cycle costs, which takes into consideration upfront costs, on-going costs and expected life (or remaining life) of the equipment.

3.3 Elements Influencing an Assessment of Equipment Condition

There are several considerations in an assessment of an existing system, as shown in the table – “Assessing System State-of-Repair” – on the following page. The equipment may be obsolete and not upgradeable. It may no longer be able to adjust to changing external factors, such as new currency designs or accessibility mandates. Obsolescence may be evident from a lack of available spare parts or trained personnel to support the software. Obsolescence leads to loss of equipment capability (e.g., inability to accept new bills). It also can lead to extended periods of unit unavailability and/or increasing costs for special-order or in-house production of parts that are now longer stocked by the original supplier. Loss of support of system software by the software developer can limit system ability to upgrade

and remain compatible with other interfacing software in use at the transit agency. Loss of reliability – a result of wear and tear – is a significant factor in assessing remaining life, as poor reliability increases maintenance costs. Reliability, however, is not the only consideration.

Barring obsolescence, the equipment may simply wear out from usage and exposure. Non-modular parts or surfaces may wear down, affecting alignment and tolerances, which in turn affect reliability.

Assessing System State-of-Repair		
Assessment Consideration	Description	Examples
Versatility	<ul style="list-style-type: none"> External factors may limit equipment ability to meet customer needs 	<ul style="list-style-type: none"> Older bank note acceptors cannot be upgraded to accept new currency designs New ADA regulations may not be met by old equipment design
Availability of Parts	<ul style="list-style-type: none"> As systems age and are replaced by newer models, parts for older models will no longer be available, requiring in-house fabrication or after-market purchase 	<ul style="list-style-type: none"> Earlier versions of CPU chips (e.g., Pentium II) are no longer available, requiring alternatives for motherboard replacements on older TVMs
Supplier Support	<ul style="list-style-type: none"> As software evolves, older generation software will not be supported by the supplier. Turnover of trained in-house personnel limits ability to administer and maintain the system 	<ul style="list-style-type: none"> Older proprietary central database managers are no longer supported and may not be compatible with newer system networks
Wear and Tear	<ul style="list-style-type: none"> Components not modular and replaceable will wear over time compromising their function and equipment reliability or security 	<ul style="list-style-type: none"> Interior component tracks, hinges, locks can result in poorer alignment and fit, reducing reliability and security
Functionality	<ul style="list-style-type: none"> Equipment may not be able to adapt to new fare system needs 	<ul style="list-style-type: none"> Limits on paper stock feeds or finite number of selection buttons may not accommodate increasing fare policy complexity. Limits on memory and operating system upgrades may bar addition of new functions
Life Cycle Cost of Operation	<ul style="list-style-type: none"> New equipment and technology may be less costly to operate and maintain 	<ul style="list-style-type: none"> Smart card technology is all electronic with no mechanical parts to wear; faster transaction times speed passenger boarding

In spite of a rigorous preventive maintenance program, certain components will wear out over the life of the equipment at some point resulting in decreasing levels of reliability. Poorer reliability leads to higher maintenance costs, as more and more frequent repairs are required of a unit. Loss of unit availability can also result in the loss of revenue if fares go uncollected as a result. This can be particularly true of more sophisticated equipment that actually collects a fare as opposed to those that simply verify a prepaid fare. A malfunctioning farebox will cause loss of fares; loss of ticket vending machines in a proof-of-payment environment can also result in loss of revenue, if passengers must then be excused from paying their fare. Loss of a swipe reader results in loss of data.

3.4 Examining Life Cycle Costs

Normal wear and tear on equipment eventually requires either a major overhaul or replacement. All other things being equal – i.e., the equipment continues to meet agency needs and is not obsolescent – a decision to refurbish or replace is driven primarily by analysis of life cycle costs. Typically, while refurbishment may be less costly than replacement, a lower expected remaining life and any differences in expected overall reliability may offset the cost differential.

The cost of replacement comes with many costs that are associated with the loss of value of existing stock. As on-board and in-station equipment is replaced, support facilities and equipment, such as cashbox receivers and test bench equipment, may require replacement for continued compatibility with the new equipment. Replacement costs also include those associated with engineering and procurement activities, including preparation of the specification and procurement documents, and staff time required for contractor selection. Personnel training are also required for the new system; personnel training for a refurbished system will be limited to any upgraded aspects to the system.

Working in favor of full replacement is the longer life that can be expected. Higher upfront costs may be offset by a lower on-going annual cost of maintenance and operation and/or a longer expected life. Payoff of the procurement may come in a few years, well before the end of the life cycle.

Analysis of life cycle costs for transit system procurements may also warrant consideration of the sources of the funding for procurement and for on-going operation and maintenance. Funding limitations for large investments will influence the decision to replace or refurbish. At the same time, the availability of grant funding for capital projects may influence the decision in favor of replacement.

Costs of Refurbishment vs. Replacement	
Refurbishment	Replacement
<p>Program Costs</p> <ul style="list-style-type: none"> • Engineering and Contracts (if outsourced) • Overhaul Labor and Materials • Replacement Modules and Components • Maintenance Spares • Testing and Acceptance <p>Long-term Effects</p> <ul style="list-style-type: none"> • Estimated Extended Life of Equipment 	<p>Program Costs</p> <ul style="list-style-type: none"> • Engineering and Contracts • Procurement Management • Equipment Contract • Parts Inventory and Maintenance Spares • Personnel Training • Testing and Acceptance <p>Long-term Effects</p>

<ul style="list-style-type: none">• Estimated reduction in maintenance costs, due to reliability improvement	<ul style="list-style-type: none">• Estimated Life of Equipment• Estimated Reduction in Maintenance Costs, with expected reliability improvement
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3.5 Examples of Agencies Modifying and/or Refurbishing Equipment

Several agencies have found it to their advantage to perform an overhaul of their equipment to extend its life. Others have modified equipment – some out of necessity – to improve the functionality of the equipment, as the table – “Refurbishments and Modifications” –shows below.

A major supplier of fareboxes will refurbish fareboxes they originally supplied, replacing mechanical components and the electronics, and reusing the housing. The support systems do not require full replacement.

Refurbishments and Modifications – Illustrations
Refurbishment
<ul style="list-style-type: none"> • Fareboxes <ul style="list-style-type: none"> ○ Cobb County Transit Authority contracted the OEM to refurbish its fareboxes <ul style="list-style-type: none"> ▪ Replaced mechanical and electrical components ▪ Replaced motherboard and upgraded software ▪ Restored unit housing
Modifications
<ul style="list-style-type: none"> • Fareboxes <ul style="list-style-type: none"> ○ GCRTA added magnetic farecard processing units to its existing registering fareboxes; fully integrated ○ CTA added magnetic and smart card processing units to its existing registering fareboxes; partially integrated ○ Bay Area transit agencies are adding smart card processing units to onboard fare systems; not integrated • TVMs <ul style="list-style-type: none"> ○ NJT replaced front panel displays and controls and upgraded software to add customer features. The tickets were condensed to two stocks and a faster bill validator was incorporated ○ SCRRA replaced printing, displays, and bill processing units to increase functionality and extend useful asset life
Modifications and Refurbishments
<ul style="list-style-type: none"> • TVMs <ul style="list-style-type: none"> ○ Long Island Rail Road overhauled its first-generation TVMs at mid-life to update and expand functionality and to achieve ADA compliance

Agencies opting to modify rather than replace include those that added magnetic farecard processing capability to existing fareboxes. Some added units to read, encode, print and issue farecards, while others added magnetic farecard swipe readers. More recently, agencies are adding smart card processing onboard alongside and interfacing with the farebox.

3.6 State-of-the-Art in Fare System Technology

As the flow chart – “Assessing the Existing Equipment” - on Page 25 indicates, a decision on the disposition of the existing system requires a determination of system needs and the alternative means of achieving those objectives – that is, what new technologies are available to replace the existing equipment. A summary of the state-of-the-art in fare system technology is provided in the table – “State-of-the-Art Technologies in Fare Vending and Fare Collection” – on following pages.

While an understanding of available technologies is important to the decision-making, technology should never drive selection of the system. Agency objectives and priorities may be most cost effectively met with less sophisticated technology. The full breadth of fare media should be considered including:

- Coins and bills
- Tokens
- Printed tickets and passes
- Magnetic farecards
 - Read-only (e.g., swipe only monthly passes)
 - Read/encode (with or without printing; disposable or recyclable)
- Contactless smart cards
 - Long-life personal card (can be registered to user)
 - Disposable (low-value, not reloadable)

Many advances in fare collection technology have come about with increased micro-circuit processing power. Whereas earlier models of fareboxes and ticket vending machines accumulate transaction and revenue data by type and totals, newer models will typically store detailed information on each transaction and track the status of each component and receptacle, triggering alerts that maintenance is required or that either ticket stock or change-making units are low in supply or that coin and bill vaults are almost full. Interfacing with other systems enables an on-board transaction at the farebox to be recorded by location, date and time, vastly improving an agency’s ability to tailor service delivery to ridership characteristics. Increased memory and processing power on either the system equipment or on the farecard itself can enable an agency to provide more services of convenience to the passenger, such as subscription “autoload” feature that ensures a card holder never runs out of fare, and even pays the lowest possible fare based upon frequency of use. The agency is also able to implement more complex fares without creating a nightmare for both those who ride the system and those must administer and enforce the fares. When a farecard is registered to an individual user, the card can be “hot-listed” and disabled for further use when lost or stolen.

3.7 Summary and Closing

The guidelines in this task have provided a straightforward means of examining system needs based upon an assessment of the state of repair of the existing system, an understanding of agency objectives and the alternatives to the existing system that are available in the industry. The decision tree provided in the overview provides a general checklist for reaching a decision for system replacement, modification or

refurbishment – or for simply keeping the system as is. The document has also provided supporting information in tabular and checklist formats for reference at each decision point.

State-of-the-Art Technologies in Fare Vending and Fare Collection	
p1 of 3	
Fare Vending Machines	
<ul style="list-style-type: none"> • Bill Acceptance <ul style="list-style-type: none"> ○ Accept 13 bill types (denominations and/or designs) in any orientation (fare up/down, both ends) ○ Escrow 15 bills until transaction completion ○ Bills returned if transaction cancelled ○ Accept 97% on first read; 99% on second attempt; reject 100% counterfeit and foreign bills 	<ul style="list-style-type: none"> • Coin Acceptance <ul style="list-style-type: none"> ○ Accept six coin denominations (including tokens) ○ Holds coins until transaction completion ○ Coins returned if transaction cancelled: <ul style="list-style-type: none"> ▪ Return inserted coins <or> ▪ Return like coins of same value ○ Accept 98% on first insertion; 99% on second attempt; reject all counterfeit and foreign coin and slugs
<ul style="list-style-type: none"> • Change-making <ul style="list-style-type: none"> ○ Coin recirculation of five denominations ○ Up to three auxiliary hoppers holding 1,000 coins each 	<ul style="list-style-type: none"> • Farecard Printing <ul style="list-style-type: none"> ○ Direct Thermal printing - 1200 by 1200 dpi ○ Landscape and/or portrait orientation ○ Graphics/symbols ○ Support Tru-type font size options ○ Support Multiple farecard sizes ○ Either roll stock or pre-cut cards
<ul style="list-style-type: none"> • Credit Card and Debit Card Payment <ul style="list-style-type: none"> ○ Card reading <ul style="list-style-type: none"> ▪ Dip or swipe style reader (card stays in customer hands) <or> ▪ Transport takes card into unit (ATM style) <ul style="list-style-type: none"> ▪ Unit can be same transport unit that reads/encodes farecards ○ Debit card personal identification number (PIN) entry <ul style="list-style-type: none"> ▪ Encrypted DUKPT compliant 12-button keypad ▪ Dual purpose keypads enable encrypted entry for debit cards, unencrypted entry for purchase selections 	<ul style="list-style-type: none"> • Magnetic Farecard Processing <ul style="list-style-type: none"> ○ ISO/IEC compliant ○ Magnetic encoding heads on printer unit encode/verify data on issued farecards ○ Dip-style transport reads/encodes/verifies data on inserted farecards; same slot for insertion and return (for validation or stored-value addition or deduction) • ISO/IEC Compliant Smart Cards <ul style="list-style-type: none"> ○ ISO/IEC 14443 Compliant – Type A and B ○ Contactless: radio frequency comm. <ul style="list-style-type: none"> ▪ ISO14443 cards read within ½ inch of unit ▪ ISO15778 cards read within 2 ft of unit ○ Reads/encodes/verifies electronic encoding ○ Transaction processing capabilities: <ul style="list-style-type: none"> ▪ Verifies validity for ride ▪ Deducts fare, based on fare structure and card type (adult, child, senior, etc) ▪ Reloads pre-approved value onto card

State-of-the-Art Technologies in Fare Vending and Fare Collection		P2 of 3
Fare Vending Machines (continued)		
<ul style="list-style-type: none"> • Customer Display and Selection <ul style="list-style-type: none"> ○ Visual display and control options <ul style="list-style-type: none"> ▪ Fixed selection buttons ▪ Keypad for selection code entry by sight-impaired customers ▪ ATM-style “soft keys” adjacent to variable message display screen;
<or> ▪ Touch screen with displayed selection menu ○ Audio instructions options <ul style="list-style-type: none"> ▪ Recorded voice ▪ Digitized voice 	<ul style="list-style-type: none"> • Communications and Control <ul style="list-style-type: none"> ○ Station “Ethernet” network connection using wire or wireless ○ High-capacity transmission: <ul style="list-style-type: none"> ▪ Private -fiber optic transmission cable ▪ Public – T1, DSL, ISDN, CDPD ○ Central Monitoring and Control System: <ul style="list-style-type: none"> ▪ Receives: <ul style="list-style-type: none"> ▪ Alarms and alerts on equipment status (e.g., intrusion, out of service, low ticket stock) ▪ Sales transaction and revenue records ▪ Clears credit/debit card transactions through bank system ▪ Downloads software, fares and bad card list updates, incl. fares, display screens, operating software to field units ▪ Notifies personnel of alarms and alerts ▪ Makes system data available to authorized personnel ▪ Interfaces with other agency reporting systems (e.g., finance, maintenance) for direct use of sales, revenue and performance data) 	
Smart Card Systems		
<ul style="list-style-type: none"> • Farecard Registration – assigns card to an individual <ul style="list-style-type: none"> ○ Value is replaced if card is lost or damaged ○ Can link card to personal account for automatic reloading (recurring autoload) 	<ul style="list-style-type: none"> • Farecard Applications <ul style="list-style-type: none"> ○ Configurable as period pass, stored-value, stored-ride, etc. ○ Can also carry a “cash purse” for paying full or incremental fares not covered by primary configuration (e.g., pass). ○ Can accommodate both transit and non-transit uses, including parking, taxi fare, retail items, in lieu of cash. 	
<ul style="list-style-type: none"> • Local purchases: on-site <ul style="list-style-type: none"> ○ Add value to farecard at: <ul style="list-style-type: none"> ▪ Ticket vending machines ▪ Validating Farebox ▪ Customer Service Terminal ▪ 3rd Party Outlet Terminal 	<ul style="list-style-type: none"> • Remote purchases: on-line <ul style="list-style-type: none"> ○ Directed autoload of farecard: prepay on web site, load value automatically at fare equipment ○ Recurring autoload of farecard: set up in advance, automatic addition of value to farecard from personal bank or credit card account when value on card reaches low-value threshold or when next period pass is required. 	

State-of-the-Art Technologies in Fare Vending and Fare Collection

P3 of 3

Fareboxes

• **Bill Acceptance**

- Accept 13 bill types (denominations and/or designs) in any orientation (fare up/down, both ends)
- Accept x% on first read; y% on second attempt; reject 100% counterfeit and foreign bills

• **Coin Acceptance**

- Accept x coins (and tokens)
- Accept x% on first insertion; y% on second attempt; reject all counterfeit and foreign coin and slugs

• **Smart Card Processing**

- Contactless: radio frequency comm.
 - ISO14443 cards read within ½ inch of unit
 - ISO15778 cards read within 2 ft of unit
- Reads/encodes/verifies electronic encoding
- Transaction processing capabilities:
 - Verifies validity for ride
 - Deducts fare, based on fare structure and card type (adult, child, senior, etc)
 - Reloads pre-approved value onto card

• **Magnetic Card Processing**

- Swipe reader for read-only format
 - Card remains in user hands
 - Verifies validity for ride
- Electric card transport:
 - Takes/returns inserted farecard in single slot
 - Issues purchased card from stack or roll stock housed in unit
 - Reads/encodes/verifies magnetic encoding
 - Thermal or dot-matrix printing
 - Transaction processing capabilities:
 - Verifies validity for ride
 - Deducts fare, validates for transfer
 - Issues change card for overpayment

• **Display and Control**

- Driver control
 - Driver Control Unit: Color LCD; adjacent “soft” keys and keypad
 - Dedicated or interfaced with existing unit
- Passenger display
 - LCD 2-line, 20 character
 - 2-button selection buttons

• **Data Collection**

- Individual cash and non-cash transactions
- J-1708 Interface for Smart Bus Application
- AVL (vehicle location) interface for boarding location and time of transaction
- Individual events, including security alarms and service alerts

• **Communications and Control**

- Wireless “Wi-Fi” communication at yard
 - Upload transaction and event records
 - Download updates: software, fares, card reloads, bad card lists
- Infra-red data probe at yard service island
 - Upload cashbox contents data
- Smartbus/Radio system interface
 - Real-time security alarms and service alerts
 - Data exchange: sales, events, card lists

4.0 TASK 5 - EQUIPMENT REVIEW

4.1 Purpose and Scope

Achieving compatibility among suppliers and among agencies is a challenging task that is driving efforts to develop the standards of fare media and reading devices as well as the software and protocols that drive back office operations. These guidelines focus on providing a straightforward and concise means of identifying and addressing issues of interoperability among transit agencies in a region. This work is a product of Task 5 – Equipment Review – of the work plan of the UTFS Operations Committee.

A checklist of items that typically arise is provided in the table – “Task 5 – Equipment Review Checklist” - on the following pages. Further discussion then focuses on the general areas, including:

- Interoperability
 - Fare Media Interoperability
 - Intellectual Property
 - Data System interoperability
- Integration of New Capabilities into Existing Systems
- Independent Payment Systems

Examples illustrate how these issues can be addressed. These guidelines are intended to be of value to agencies of any size and a region of any number of agencies.

Task 5 – Equipment Review Checklist			
#	Item	Description	Comment
1	Inter-Agency Agreements	One or more formal agreements between participating agencies where common fare media will be used. Agreements govern how and where media will be used, operating rules and policies, methods of revenue reconciliation, fare media distribution, and other responsibilities of each agency.	Agreements should be in place prior to design of overall system architecture, and should reflect mutually defined requirements for the AFC system and its fare media.
2	Intellectual Property Rights	To enable interoperability between modes and/or agencies, as well as future expansion of the AFC system, comprehensive documentation describing the format in which data is recorded on machine-readable fare media, and the ways each data field is used, must be provided. The participating agencies must have perpetual rights to use this information, or obtain outright ownership. In addition, where applicable, encryption algorithms and the means to generate and propagate encryption keys must also be documented fully, with similar rights or ownership conveyed to the agencies.	Rights to intellectual properties that are necessary for inter-agency and inter-modal use future expansion of the system should be secured prior to executing a contract with the AFC supplier.
3	Interoperability Requirements	Are multiple agencies involved? Are multiple modes of transit involved?	The scope of interoperability requirements will have a direct impact on the architecture of the overall AFC system, especially regarding the centralized data system and whether a third-party clearing house would be considered.
4	Shared Fare Media	What technology is being deployed for the shared fare media? Read-only magnetic, read/write magnetic, or contactless smart card?	The choice of shared fare media technology can affect the effort required to integrate new modules into existing equipment, whether new equipment is required, the data required for interoperability, and the features and policies that can be offered.
5	Fare Media Data Encoding	Is the data encoding format new, or one that has been previously deployed?	New formats make possible the outright ownership of the intellectual property, but also require the supplier to put forth greater non-recurring engineering effort, introducing greater risk to the project. If the supplier is providing a previously used format, or a “standard” format is required, perpetual access to the intellectual property rights must be secured.

Task 5 – Equipment Review Checklist			
#	Item	Description	Comment
6	Encryption Algorithm and Keys	Will data on the fare media be encrypted?	If data encryption is to be used, be sure to receive complete documentation on the encryption algorithm. In addition, the encryption keys must be generated and distributed to all devices in a secure manner; these procedures must also be fully documented.
7	Media Compatibility Verification Tools	For each fare instrument being shared (either between modes or between agencies), a “golden” card reader should be acquired for a compatibility verification tool. This tool should be kept in “laboratory” condition, that is, in as perfect working condition as possible.	The “golden” card reader should be an integral part of any AFC procurement, and may be procured by any participating supplier. Often, the “golden” reader is provided by the supplier who is providing the highest quantity or the most project-sensitive read/write modules. The tool should be used as part of the pre-revenue service certification testing, as well as for ongoing quality control (once the system is in service).
8	Clearinghouse	If multiple agencies are participating, who will perform the clearing house functions?	Often, a regional oversight agency can provide the clearing house function, but in many cases this role is assigned to a third party (integrator), or the primary/largest agency in the region.
9	Data Integration and Architecture	The suggested system architecture illustrated in the figure on page 40 is one of many possible solutions.	The chosen architecture should address the capabilities and needs, as well as the requirements, of the participating agencies. Some agencies will insist on retaining control over their data, while others may be inadequately staffed to assume the responsibility of maintaining and administering these sophisticated systems. In addition, it is generally recommended that the suppliers be allowed to provide as much of their existing (albeit proprietary) systems as possible to reduce costs and risks, as well as to simplify the integration tasks.

Task 5 – Equipment Review Checklist

#	Item	Description	Comment
10	Data Required for Interoperability	The data fields required to properly reconcile accounts between participating agencies (or even between lines of responsibility within an agency) are a small subset of the total data that is generated by modern AFC systems.	For cost-effective and quality design, it is essential that all required data elements be identified as early as possible. Generally, while most of the data elements can be specified in the contract documents, the participating suppliers (and the third-party clearing house integrator, if applicable) should convene regular design conferences to ensure that all data fields to be shared are identified and included in the designs.
11	Integrating New Capabilities into Existing Systems	If the project involves integrating new modules into existing systems equipment, many issues can arise that are not present when working with a “clean sheet of paper” for new design.	To the extent possible, use an “intelligent black box” approach to the task of integrating new modules into existing equipment. This will greatly simplify the interfaces between the new and old equipment, and will make it more likely that the new equipment can be provided by a new supplier (which makes open procurement possible). This is especially important when interoperability requirements will involve augmenting equipment from multiple suppliers or multiple models/vintages from a single supplier.
12	Fare Media Distribution	How and where will new fare media be sold? If the media is reusable, how and where will patrons be able to replenish value to their existing media? Failure to provide sufficient means to buy and replenish media can greatly hamper the market penetration of the media.	Typically, new fare systems are in part justified by the increased convenience they offer to the patrons. Among these conveniences are additional and/or streamlined ways in which patrons can purchase or replenish their media. When multiple agencies are involved, there are usually multiple venues and methods of selling media, too. These must be carefully coordinated to prevent confusion, especially during initial roll-out of the new system. Moreover, when multiple sources of sales revenue are involved, the clearing house function can be made more complex.

Task 5 – Equipment Review Checklist			
#	Item	Description	Comment
13	Automated Replenishments	Are autoloader features being introduced?	These features are very popular, but they can be very complex undertakings, both for the agencies and the patrons. Because these features eliminate the need for patrons to visit sales outlets, autoloader functions can greatly reduce the infrastructure needed to support media sales and replenishments. Due to the complexity of these features, agencies often introduce them as system enhancements after the system has been in service.
14	Employer-Sponsored Programs	Employer sponsored patrons (i.e., Transit Check users), are becoming a vital part of many agencies' ridership. Centralized billing systems, coupled with the expanded data capabilities of new fare media, permit many efficiencies to be introduced to these programs, both for the agency and the employers.	The chief drawback to these programs is that they can require significant administrative overhead. If properly designed, the central data system can support the databases necessary for employers to easily manage their employee benefits. When provided via secure Internet connections (password protected to restrict an employer to only their employee data), these systems can greatly reduce the effort required to maintain employee benefit selections, while at the same time streamline the process of invoicing the employer. When multiple agencies are participating in the AFC project, significant economies of scale are introduced by centralizing the administration of these programs at the central computer system (perhaps managed by the clearing house contractor).

4.2 Interoperability

When evaluating new procurements or modifications to existing systems, especially when new fare media are to be supported, an essential element to be considered is the ability of the new or modified equipment to operate as a cohesive system. The extent that one defines the boundaries of the “system” will determine the degree to which elements that comprise the system must interoperate.

For example, if the system is supporting a single agency with only a single mode of transit, such as a bus-only operator with no adjoining agencies, then the system’s interoperability requirements are limited to the various components on the bus, the garage(s), and the central data system. Such single-dimensional systems are inherently easier to define, and with a minimum number of internal and external interfaces, the dimension of interoperability is also minimal.

However, as soon as the AFC system must support multiple agencies, multiple modes of transit (with accompanying different methods of collecting fares), or both, the complexity of the system increases dramatically – both in terms of the variety of equipment to integrate and the external interfaces. Moreover, as the variety of fare media increases, so, too, does the task of integrating the various elements of the system into a coherent whole.

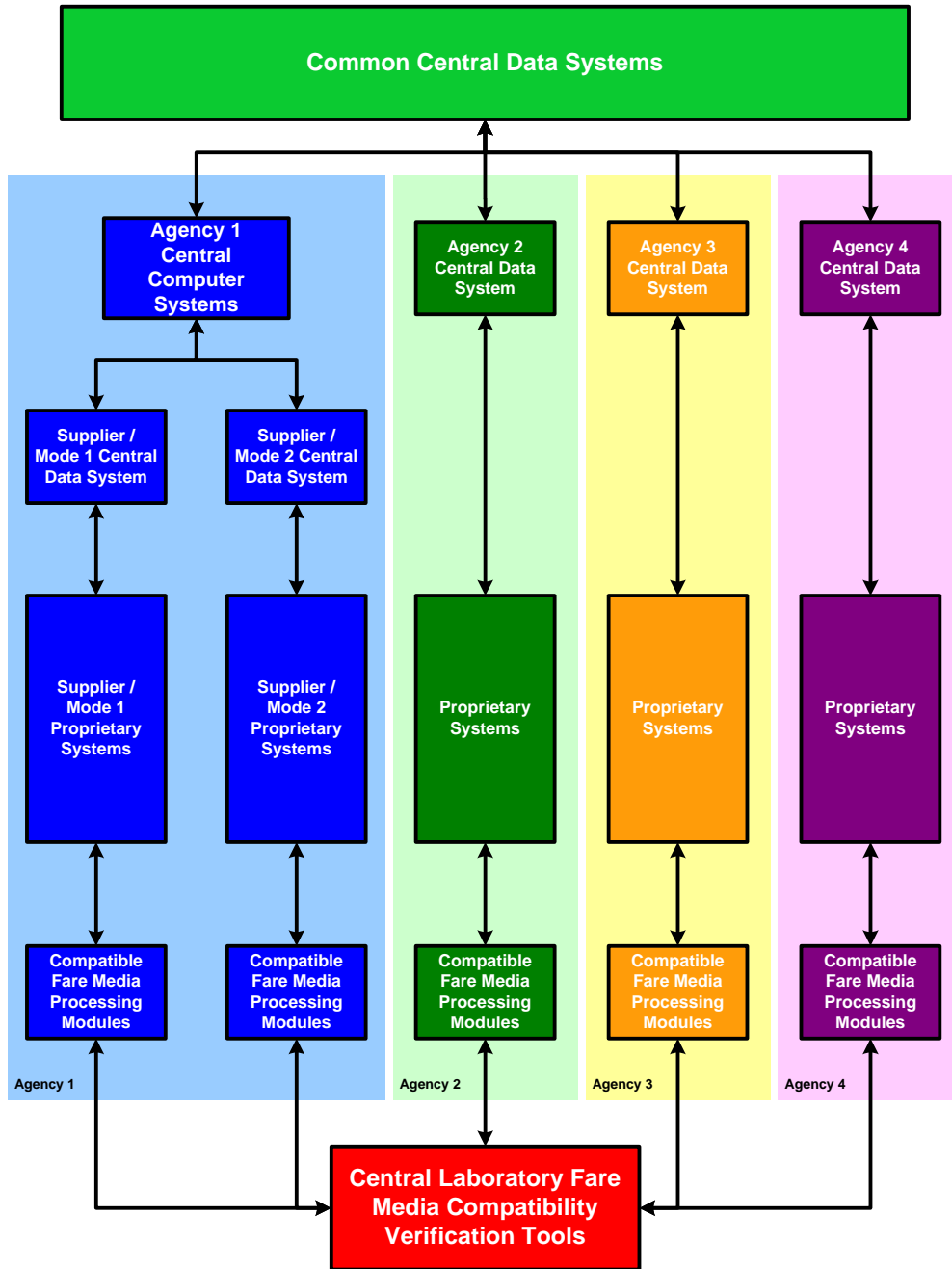
For the sake of this analysis, the model for assessment will be perhaps the most extreme case: a region with multiple agencies, multiple modes of transit, multiple AFC system suppliers, and a multitude of fare instruments and policies. Simpler interoperability scenarios (such as a single agency with multiple modes) share virtually all of the same concerns of the more complex situation described herein, but at obviously smaller scales.

The figure – “Fare System Interoperability among Several Transit Operators” - on the following page provides an overall architecture of such a system.

This simplified diagram depicts how interoperability on this large scale is a function of the “bottom” and “top” ends only. Proprietary hardware and data systems are entirely supportable in these wide-spread solutions so long as common fare media is usable on all systems (as certified by the centralized compatibility laboratory tools), and so long as the necessary common data is made available to and from all of the participant systems.

One key element of these multi-agency systems is that the only data that must be commonly available to and from the centralized data system is that which is necessary to support the inter-agency agreements for revenue sharing. This greatly simplifies the task of integration, since much of the data that is collected and processed at the agency- or supplier-level systems is by its nature proprietary (both to the agency and the supplier). For example, records of maintenance events on one agency’s Ticket Vending Machines are of no interest to another farebox-only agency. Moreover, such records are also in a format that would be specific to the TVM supplier’s design, and would be difficult to interpret by a third-party’s data system.

Fare System Interoperability among Several Transit Operators – One Scenario



Among the records that would typically be shared for common central database integration are:

- Usage transaction records (usage/boardings)
- Fare media purchase and replenishment transaction records
- Lists of farecards to be rejected (*i.e.*, “hot lists”)
- Lists of cards which are to receive automatic replenishment (*i.e.*, “autoload” lists)
- Common pricing structures and fare tables (as defined by the inter-agency agreements, or where a single agency has a common fare structure between modes)

4.2.1 Fare Media Compatibility

The use of one or more common fare media between multiple agencies and/or multiple suppliers requires compatibility on several levels.

A. Physical and Read/Write Interfaces

1. Magnetic Media

For magnetic media, physical characteristics of the cards (including dimensions, thickness, stiffness, coefficient of friction, etc.) must be carefully defined so that all magnetic read/write devices will be designed properly. Often, fare collection systems can include devices that dispense magnetic media (such as Ticket Vending Machines), and devices that process magnetic media (such as fareboxes, fare gates, validators, Add-Value Machines, etc.) The degree to which each device must be physically compatible with the media may differ, depending on what the device is expected to do and the variances that can be tolerated.

For example, a dispensing module which also encodes and prints a magnetic ticket upon issue, but will never process previously dispensed media, should be designed to very tight tolerances and be expected to produce near-perfect cards every time. (After all, the media will be pristine, and since previously issued cards will not be inserted for processing, it should be easy to maintain optimal performance.) On the other hand, a device that must process previously issued magnetic media should be able to tolerate cards that have been slightly abused, so the transport path should permit cards that are outside of the ideal physical characteristics.

Quite obviously, fundamental to magnetic media compatibility are the characteristics of the magnetic stripe itself and the components that read and encode data on the stripe. Magnetic encoding is defined by several factors, including:

Location of the magnetic stripe, usually defined according to ANSI/ISO standards as being in tracks 1, 2, 3, or some combination of those three (for modern AFC systems, most commonly tracks 2 and 3).

The coercivity of the magnetic stripe, which defines the strength of the magnetic field necessary to record on the stripe. Most modern AFC systems use “high” coercivity, which is typically defined as 1750 Oersteds. Note that coercivity affects only the encoding process; if a device is read-only; the coercivity of the magnetic stripe is of little consequence.

Bit density, which is a measure of the number of data bits per inch. While there are ANSI/ISO standard bit densities, non-standard densities are common in AFC systems. Significant variations in bit densities between suppliers and devices can also be tolerated, provided that no extraneous data is left on the card after each encoding. (A higher bit density – more bits per inch – requires less length to encode the same data as a device writing at a lower bit density. As long as the rest of the card is erased or written with data that is recognized as start or end “sentinels,” higher than required bit densities are easily accommodated.)

Compatibility of magnetic encoding can also be determined by several other highly technical characteristics, including “jitter,” encoding methodologies (such as “F2F”), skew angles, and so on. To assure compatibility, a comprehensive design document should be produced by the “lead” supplier to permit other suppliers (and future suppliers) to design their systems properly.

2. Contactless Smart Card Media

As their name implies, contactless smart cards are not required to make physical contact with the reader. Hence, the physical compatibilities issues become moot and the “package” in which the card’s circuitry is placed can vary in size and shape. (Some contactless smart “cards” are placed in key fobs and even wrist watches.)

The critical interfaces for contactless smart cards are defined in the ISO 14443 standard, parts 2 through 4. This standard defines how a contactless smart card communicates with its reader, how data is read and written, and how other communications functions, such as multi-card collisions, premature removal of the card (“tearing”), are to be handled.

Notably, the ISO 14443 standard presently recognizes 2 varieties of cards, types “A” and “B,” with other types under consideration for acceptance as part of the standard. The two currently accepted varieties of standard card are technically incompatible with each other due to their differences in how data is exchanged between the card and the reader. However, most suppliers of ISO 14443-compatible card readers provide equipment that is capable of reading both card types using a single device; as a consequence, most systems that are ISO 14443 compliant are now independent of the card type.

B. Data Encoding Formats

While the various industry and international standards for magnetic and smart card fare media define the physical characteristics and communications methods between readers and cards, the standards do not define the layout of the data that is recorded on the card, nor do these standards described how each data field is used and interpreted. Rather, the data encoding formats are usually designed by the supplier, and no encoding format standards exist for transit applications. (The banking industry has copious standards for data formats that apply to credit and debit cards, but these are not relevant to transit fare media.)

The encoding formats provided by AFC equipment suppliers are all of proprietary design. However, because the data encoding format is a substantial foundation to all of the application software and database structures that comprise a complete AFC system, the designs of these formats are intended to address all known fare policies that are likely to be addressed with any fare medium on which the format can be encoded.

For example, the read-only magnetic swipe cards widely used as calendar-based monthly passes contain an encoding format that permits a variety of unlimited ride passes of differing validity periods, fare types, zones, etc. The suppliers have long settled on how to address the vast majority of unlimited ride passes used, so the encoding formats for these media are very mature. Similarly, magnetically-encoded transfers, day passes, stored value cards, floating period passes, and so on, have also employed comprehensive data encoding formats that have been developed by their suppliers and have remained nearly unchanged for many years.

The relative newness of contactless smart cards, coupled with their greater data storage capacity and flexibility, have resulted in data encoding formats that are still being “tweaked” by their respective suppliers. As with the magnetic encoding formats, each supplier has developed their own proprietary formats. However, recent developments in Houston and in the New York region suggest that some common – perhaps even “standard” – contactless smart card data formats may emerge.

In Houston, Cubic and Scheidt & Bachmann jointly developed a smart card encoding format so that both bus systems (supplied by Cubic) and rail systems (supplied by S&B) can share a common card. In the New York region, the major transit agencies are sponsoring the development of a comprehensive Regional Interface Specification (RIS) that defines all data formats required for a multi-agency, multi-supplier AFC system for the entire region. This specification includes all information necessary to read and write common smart card fare media.

Whether an AFC system uses proprietary, shared, or “standard” format for machine-readable media, it is important to understand that the layout and defined uses of each data field are among the linchpins of the design. Without complete documentation of the encoding format(s) used, the AFC system cannot be expanded to another agency or by another supplier.

C. Encryption Algorithms and Keys

Generally speaking, the vast majority of magnetically encoded fare instruments do not employ encryption of the data. While all data is encoded in binary form (ones and zeros) and with data fields of variable length (making interpretation of the data extremely difficult without the “roadmap” of the encoding format documents), the data on magnetic fare media is not “transformed” by an algorithm using a secret key; that is, the data is encoded in the same form that is called for in the encoding format documents.

Conversely, most contactless smart card fare media do employ sophisticated encryption methods so that the data that is on the card (and hence transmitted via radio signals between the card and the reader) is unintelligible. To properly read and write a smart card that uses encryption, two elements must be commonly understood by all read/write devices: the encryption algorithm used and the unique set of keys (typically 16-digit hexadecimal numbers or greater) used for the specific AFC project.

Since the encryption keys must be unique to a project to preserve maximum security against fraud, the keys must be highly guarded “secrets” of the agency. At a minimum, no single person should know the complete key set; ideally the keys are generated by a specialized program and stored in a form that is only machine-readable. In no instance should the keys ever be stored in unencrypted form on a computer or other device that is accessible to others.

All of this security surrounding the encryption keys presents a problem, however: how to disseminate the keys to each read/write module, especially when more than one supplier and/or agency is involved *without compromising security*. Just as the encoding format must be fully documented for interoperability and future expansion, so, too, must the encryption algorithm and the secure processes used to generate and propagate the keys.

When data encryption is employed, the best designed AFC system, using the best documented encoding format, will fail to interoperate between suppliers and agencies if a common encryption algorithm and common keys are not properly implemented. Any hopes of expanding a successful system that uses encryption will also depend on the thoroughness of the documentation regarding the algorithm and key generation and propagation processes.

D. Media Compatibility Verification Tools

As illustrated in the figure – “Interoperability of Fare Systems of Several Transit Operators” - on page 41, it is highly recommended that any multi-agency or multi-supplier AFC system employ a common fare media compatibility verification laboratory. The devices in this laboratory act as the “golden” card read/write devices against which all other in-service devices will be measured for proper performance. Often, these tools also provide substantial diagnostic capabilities to assist in identifying problems.

These tools should be used prior to commencing revenue service to confirm that cards written by samples of all fielded devices can be read by the “golden” card reader, that cards written by the “golden” card reader can be read by representative samples of all fielded devices, and that all varieties of invalid cards (created by the “golden” card reader) are rejected by all devices. These tests should be as comprehensive as possible, and cover the entire spectrum of fare instruments that will be in circulation.

As with all of the other fielded read/write modules, the “golden” card reader should also utilize the same encryption algorithms and keys; otherwise, all encrypted data will be unreadable.

4.2.2 Intellectual Property

As AFC systems have grown in sophistication, the amount of software and hardware engineering required to produce them has also grown. Suppliers routinely protect their investments through patents, copyrights, and other rights of ownership associated with intellectual property. For the purposes of interoperability, it is critical that the agencies involved either own outright or have perpetual unfettered access to the intellectual property regarding the encoding format, encryption algorithms, and key generation and propagation procedures. Without a prior agreement regarding access to this critical intellectual property, future expansion involving additional suppliers will be impossible.

In most cases, the supplier(s) will likely have pre-existing data encoding formats, so outright ownership will be difficult if not impossible to obtain. (To grant ownership for a pre-existing format, the suppliers would have to gain permission from all prior users of the property, an extremely unlikely scenario.) If, however, a new format is being developed expressly for the project, it may be possible (or even necessary from a legal perspective) to gain ownership.

In cases where a pre-existing format is being utilized, the participating agencies must acquire licenses in perpetuity that grants the agencies the ability to use and disseminate the intellectual property as necessary to maintain and expand the system. Since future expansion may involve third parties, it is likely that a formal Non-Disclosure Agreement (NDA) will be required between the agency and the third party. (It is highly recommended that the original supplier of the system *not* be a signatory to the NDA, since the third party may be a competitor of the original supplier, and such agreements between competitors can be extremely difficult to reach.) The terms included in the NDA (which may be used in the future) should be defined as part of the license agreement, but should in no way hinder the agency from entering into contracts with any legitimate supplier.

4.2.3 Data System Interoperability

The figure – “Fare System Interoperability among Several Transit Operators” – on page 41 depicts a generic multi-agency, multi-supplier regional AFC system. While numerous alternative architectures are possible, the most practical solutions allow the suppliers to leverage their existing proprietary systems to manage and operate their systems, while depending on standard database and communications interfaces to share required common data with a centralized “umbrella” data system. The suggested architecture also permits each agency to retain ownership and control of data that is of importance to them.

Of course, any level of inter-agency interoperability presupposes that the necessary inter-agency agreements have been firmly established and codified.

The types of data elements that are typically required for centralized integration of data systems include following:

A. Use (Entry/Boarding) Transactional Data

Every time a patron boards a vehicle, passes through a faregate, or otherwise processes their farecard (such as at a stand-alone validator or with a hand-held fare inspector’s device), a transaction record is stored at the device and later communicated to a central computer. (Obviously, many boardings in proof-of-payment systems do not have a transaction record.) Each of these transaction records contains information that is vital to establishing usage, transaction and residual value, initial activation of floating period passes, and so on. Typically, these records include (many other data fields are possible):

- Transaction identifier/sequence number
- Date, time
- Vehicle, device, or station identifier
- GPS location data (where applicable)
- Vehicle operator (where applicable)
- Farecard serial number
- Fare type
- Transaction type and/or value
- Boarding type (initial, transfer)

Although many other data fields can accompany each transaction, the above fields are among the more important, and are usually part of any centralized data system as part of a multi-agency clearing house.

B. Sales and Replenishment Transactions

Today, agencies employ a broad spectrum of methods to sell and distribute fare media. In addition to agency-operated over-the-counter sales outlets, fare media may be purchased or replenished via self-service vending machines, the Internet, retail point-of-sale terminals, sponsoring employers, schools and universities, various forms of automatic reloading of cards (usually called “autoload” methods), and other participating transit agencies in a region. With sales revenue potentially coming from so many sources, it is imperative that all sales transactions be collected in the common central database so that revenues can be properly shared between participating agencies, and so that the status and inventory of circulating fare media can be properly tracked.

Similar to usage transactions, these sales and replenishment transactions typically include:

- Transaction identifier/sequence number
- Date, time
- Device, vehicle, or station identifier
- GPS location data (where applicable)
- Device or vehicle operator (where applicable)
- Farecard serial number
- Fare type
- Transaction type and/or value
- Bonus amount added (where applicable)
- Sale type (new / replenishment / autoload)

As mentioned, each time a new card is sold, the central database must be informed so that the card can be properly placed in the “in-circulation” inventory. Similarly, the central database should be constantly updated with the status and value of each card in circulation; the usage and sales data records will provide such up-to-date status (or as current as possible, since off-line transactions such as occur on buses may require several hours to a few days to upload into the central computer).

C. Bad Card Lists (Hot lists)

Where fare media is serialized, it is possible to notify the card readers in a system that a specific card or range of cards is to be rejected. The list of such cards should be common amongst all devices in the AFC project, so a single list, centrally maintained and “broadcast” to all devices is often used.

How this list is created, and how specific serial numbers are identified for placement on this list, is subject to agency-specific operations and procedures. Most commonly, a card is placed on the “hot list” because it has been reported lost or stolen, or because it has been identified as being used fraudulently.

In the first case – loss of the card – some program of registering cards to their owners is usually required. To register a card, the owner of the card must prove that he/she has possession of the card, and provide some form of identification and password. This information is recorded by the agency. When a patron claims the card is lost, the patron’s identity is verified by the password on record, and the associated serial number is then placed on the hot list. The patron may then be given a replacement card with the residual value on the card (as reported by the central database), minus any service fees that the agency deigns to collect.

In the second case, fraudulent use is usually detected by sophisticated monitoring software, which looks for card records that indicate that the card has more value than records can justify, or cards which are not in the recognized “in-circulation” state.

Once the updated hot list is broadcast to the devices, any attempt at using a card on the list will be rejected by the device, and the card is then encoded in such a way that it is disabled. Upon being disabled, the usage transaction record from the device will indicate that the hot listed card is no longer functional (the transaction type field would indicate “hot listed, deactivated”). The central computer can then automatically remove the card number from the hot list, keeping the length of the list to a minimum.

D. Action Lists (Autoload Lists)

If the AFC system employs automatic replenishment of value or pass privileges to cards in circulation, one way to do so involves a list of cards and transactions to be performed. In some cases, the autoload functionality can also perform other actions, such as placing subscription information on the card, or assigning the card to a sponsoring employer. The autoload function is essentially the opposite of the hot list; instead of disabling a card on the list, a card on the autoload list has additional value or products added to it. Similar to the hot list, the autoload list should be centrally managed so that all devices share a common list of actions to perform. And, when a card has received its designated autoload, the card records that fact so that it does not receive a duplicate upon presentation to another device, and the transaction record that is uploaded to the central computer results in the card’s entry on the autoload list being automatically removed.

E. Common Fare Pricing Tables

One final essential element to interoperable data systems is sharing a commonly understood fare pricing table among all elements of the AFC system. To the extent possible, the central “umbrella” data system should have the ability to define and control the fare pricing, bonus structures, expiration intervals, and other elements of the common fare policy that control how much and how the patron pays, regardless of the mode or service provider used. Since fare structures are usually highly customized, and subject to significant policy changes over time, the data interfaces for fare tables may be highly customized, and should certainly provide a great deal of flexibility to accommodate what may be unpredictable changes in fare policies.

4.3 Integration of New Capabilities into Existing Systems

In many instances, it is economically infeasible to perform a wholesale replacement of an existing fare collection system for the purpose of introducing new fare media and technology. Instead, new technology and new media are “overlaid” onto the existing system. For many farebox-only systems, retrofitting read-only and/or read-write magnetic systems can be easily and economically accomplished. Adding new magnetic media capabilities to existing systems involving other fare collection devices, especially when multiple modes and/or agencies are involved, is generally deemed impractical, and contactless smart cards are found to be an easier upgrade to achieve.

The complexities of adding new capabilities to existing systems can be significant, but because of the computational requirements of processing smart cards, these devices can often be considered intelligent “black boxes,” which can greatly simplify the data interfaces. (Assuming that physical interface and integration is possible, the greatest challenges in adding new media processing modules to existing systems are data and user interfaces.) By encapsulating the additional module with its own “in-box” intelligence, the existing devices can be relieved of the substantial tasks of processing the media, and only be concerned with the results of the transactions, and providing supporting information necessary (such as hot lists, autoloading lists, and fare tables). With this approach, the task of integrating the new module into the existing systems is shared by all suppliers, but the onus of interoperability between all modes and agencies is squarely placed on the shoulders of the “black box” provider.

Among many possible examples, two interesting cases of integrating new capabilities stand out. In Seattle, the regional agency has contracted with ERG to augment all bus and rail systems with a common smart card system. Using the “black box” approach, it is anticipated that a common smart card read/write module will be integrated into the region’s GFI Cents-a-Bill fareboxes, and the Sounder commuter rail system’s Scheidt & Bachmann Ticket Vending Machines. ERG will supply a central data system to act as the clearing house for all smart card transactions and related data.

In a highly unusual approach, when CTA adopted read/write magnetic fare media using equipment from Cubic, CTA opted to retain their GFI Cents-a-Bill fareboxes. A Cubic-supplied read/write magnetic ticket processor was added to the GFI farebox, and the GFI software was modified by CTA and a subcontractor to integrate the two devices’ functions. At the same time, Cubic supplied new faregates and TVMs for the rail system, eliminating the complexity of retrofitting existing rail equipment. Since Cubic also supplied the CTA with a new central computer system, all magnetic farecard transactions are centrally tracked.

4.4 Independent Payment Systems

When multiple agencies share common fare media, it is usually for the purpose of permitting patrons to conveniently travel using any of the region’s service providers. Consequently, patrons may purchase their fare media using an outlet under the auspices of one agency, and then consume that value using the services of several agencies. The “selling” agency must somehow compensate the “providing” agencies in a fair and equitable manner. To do so, all agencies involved must agree on the formulas and methods for the redistribution of revenues, and some oversight agency is usually chartered with the task of managing and auditing the results. This oversight, managing, auditing, and redistribution function is usually referred to as the clearing house.

Operations of the clearing house are entirely dependent on the data that is provided by the central “umbrella” data system. Because of the necessity of the central system to know the identity and current value of all cards in circulation, all usage and sales transactions should report to the central system. Fortunately, this makes the task of the clearing house as simple as possible, regardless of whether the transaction is a usage, or whether it is a sales transaction. These records are also independent of the method used to purchase or replenish the fare media (*i.e.*, cash, credit, debit, company invoice, etc).

A somewhat recent development in smart card fare collection is the deployment of systems that automatically replenish patrons' cards based on information that is encoded on the card. These automatic replenishments are tantamount to subscriptions that are triggered by either a threshold value being crossed (such as when a stored value card falls below \$10 in value), a card's pass expiring, or a period of time elapsing (such as the start of a new calendar month). Depending on the type of subscription transaction and the agreements with the cardholder or their sponsor, these transactions can trigger an automatic credit card authorization, post-billed invoice, or paid-in-advance invoice. All of these functions should be the responsibility of the central computer system to ensure that all such transactions are treated equally and recorded centrally for reconciliation.

The previous examples of automatic replenishment were based on the card having information that identifies its value and/or validity. The card read/write modules will attempt to process every card presented, except those that are on the hot list. An alternative method of providing automatic replenishment is to have the card act as merely an identification device. In such cases, each card is associated with a payment method (such as a credit card or an EFT account). The central data system tracks usage of each card after the fact, and when a card's *calculated* value falls below a threshold amount, or when a card's known expiration date passes, the central computer system will automatically conduct a payment transaction using the payment method on file. Only if the payment method fails will the card be placed on the hot list; otherwise, the patron is free to use the card as often as desired. Again, because these payments are centrally processed and collected, the clearing house function can be straightforward, with revenues distributed based on the inter-agency agreements in effect and actual usage of the farecard.

5.0 TASK 8 – IMPLEMENTATION OF NEW EQUIPMENT AND RELATED SYSTEMS

5.1 Purpose and Scope

This section provides guidelines for implementing a new fare collection system. The guidelines are a product of Task 8 – Implementation of New Equipment and Related Process – of the work plan of the UTFS Operations Committee. They are intended to be of value to an agency of any size for a fare collection procurement of any complexity. Some aspects of the plan may not pertain to all procurements, and responsibilities among individual departments may differ by agency. Each agency should adapt the plan to meet its specific needs. The section is organized to provide an overview of the implementation process, discuss implementation management, and then provide a general description of the task groups. The appendices provide tools for planning implementation of new fare collection systems. Tasks and activities are organized by task group and by sequence of activity. Primary and support responsibilities are identified, although each agency must match functions to those of its own organization. The intent is for these tools to be applicable to projects of any size and system type.

5.2 Implementation Planning Overview

Implementation of a new fare collection system - whether large or small – requires careful planning and management to be successful at start-up. A comprehensive implementation plan provides a basis for the many activities that must be accomplished in advance. All tasks must be identified, assigned, tracked and accomplished in a systematic and timely manner. The implementation plan provides this information. It identifies the tasks, assigns responsibilities, and provides timeframes for their completion. Timeframes take into account task sequences, identifying prerequisites and dependencies. The Plan also describes the Project Management Team that will have overall responsibility for start-up.

5.2.1 Components of an Implementation Plan

A good implementation plan will be comprehensive and thorough in content, yet concise in presentation and format. Components of a comprehensive plan include the following:

Implementation Plan Components
Tasks Descriptions of all necessary tasks required to prepare for system implementation
Task Sequences: relationships among tasks in terms of prerequisites and dependencies
Task Responsibilities: those with primary responsibility, and those in support, review or approval roles.
Task Schedule – an overall schedule that identifies expected start and completion dates for each activity and enables the project manager and team to monitor overall progress and identify hot spots requiring attention
Program Management – a project manager needs to be assigned to ensure that the program proceeds as planned. A project management team is assembled to involve all departments with a key role in either its design and installation or its operation and maintenance once installed.

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5.2.2 *Managing Implementation*

Managing implementation requires a project manager who will be assigned the time and resources to manage the entire program. This includes the procurement contract itself, which may involve technical and contract management support, and the all other activity that is undertaken to prepare the agency for system installation and commissioning and system operation and maintenance. The project management team should include representatives of any department with a role in design review, preparation of interfacing vehicles, systems and facilities, public education, and system function.

Project meetings need to be held on a regular basis to review program status and address any issues that may be impeding progress and threatens timely project completion. All meetings and any decisions or actions taken thereof should be documented and distributed as information to participants so there is no miscommunication or misunderstanding.

The implementation plan itself should be treated as a dynamic document that should be regularly updates as the fare collection procurement progresses in order to track implementation status and task completion and to identify new tasks as they arise.

5.3 Implementation Tasks

Eight implementation task groups are identified in the implementation plan. The first three concern the period between selection of the fare collection system to be procured and selection of a contractor to provide the system. The next two focus on the fare collection system contract itself. The remaining task groups focus on activities that must proceed concurrent with the contract itself to prepare the agency, its personnel and the public for system start-up.

5.3.1 *System Development*

This first phase includes those tasks that define the system that is to be procured, and the method of procurement.

5.3.2 *Contract Document and Specification Preparation*

With the system defined, contract documents are prepared for solicitation. The documents include technical specifications, terms and conditions and supporting information including technical drawings.

5.3.3 *System Procurement*

When the contract documents are complete, reviewed and ready, the contract is advertised and bids or proposals are solicited. Following an evaluation process, the contract is awarded, negotiated and signed. Notice to proceed starts the next phase, which includes the remaining task groups.

5.3.4 *Design and Test*

With notice to proceed, the selected contractor commences a series of steps in design of the system. A series of documents identified in the contract is submitted by the contractor and reviewed by the agency project management team and other stakeholders. Prototypes of the equipment and focus groups of personnel and riders can be utilized during the design process to improve system design. Once design is approved, there follows a number of tests that involve rigorous in-factory testing of first article production units, and then quality assurance tests of all production units.

5.3.5 *Installation, Test and Acceptance*

Once the system design has passed muster through a series of tests specified by the fare collection system procurement contract, approval is given to produce and install the entire system. A small pilot test may be conducted prior to full deployment to ensure that the system will perform reliably in real world conditions. With full deployment, the system undergoes additional testing during installation and following system start-up. Only after the system is determined to have achieved the specified levels of reliability, maintainability and reporting accuracy is final acceptance granted.

5.3.6 *Board Action*

Board action may be required to revise fare policy as part of the overall program for a new fare collection system. If a proof-of-payment system is to be implemented, additional Board action may be necessary to establish regulations for enforcement of fare payment.

5.3.7 *Education and Awareness*

A program to prepare the riding public and the public in general for the new fare collection system is needed to minimize any confusion that may occur when a new system with new procedures for paying fares is inaugurated. In addition to the public, elected officials and institutions that rely on transit service, such as schools and service agencies, need to be informed of agency plans for a new fare collection system. All agency personnel should be familiar with the new system as well.

5.3.8 *Proof-of-Payment Implementation*

A new fare collection system that incorporates proof-of-payment fare inspection is a radical change in process that has its own preparatory requirements. These may include revisions in state codes on fare evasion, and establishment of fare enforcement and violation processing functions. Coordination with and the cooperation of local courts and law enforcement organizations is critical for a proof-of-payment fare collection system to succeed.

5.3.9 Agency Preparations

All departments that have some function in the collection and processing of transit fares will be affected by the implementation of a new fare collection system. The degree to which they are affected will depend upon the degree to which the method of fare collection changes and the significance of changes in the equipment and system operation. Each department with a role in fare collection may need to budget for additional personnel and materials, recruit and hire new personnel or reassign existing personnel, prepare new procedures, train its personnel, procure the supplies and prepare its facilities for the new system.

5.3.10 Critical Activities

As the agency and its project manager proceed with system procurement and start-up, it is critical to be mindful of those long-lead items that will not be entirely under agency control to manage completion. These include any activity required of third parties, including interfacing systems with different contractors, the local court system and law enforcement agencies, and the state legislature. Sufficient time should also be provided for any Board activity.

5.4 Contents of the Plan

As a guideline to preparing for implementation of a new fare collection system and equipment, this document includes the following:

Implementation Plan Contents
Description of Implementation Tasks: Each task within the task groups identified in this task report is described in greater detail.
Sequence of Implementation Tasks: A flowchart shows the sequence of all tasks identified for action by the agency and their relation to other activities by the contractor providing the fare collection system. The flowchart provides a clear picture of the relationships among tasks, the prerequisites, and the dependencies.
Implementation Task Responsibilities Spreadsheet: A spreadsheet provides a means of tracking each task, identifying primary and secondary responsibilities for each, prerequisites and dependencies, expected duration, start and end dates, and task status.

The spreadsheet presented in this report is a simple, straightforward means of tracking tasks. Alternatives include use of database (Access) or scheduling (Project) application software. The use of database management software provides a greater ability to expand the amount of information for task description, status and responsibilities. Access software enhances the ability to track, sort, and filter the database. The project scheduling software provides a more effective means of tracking tasks according to schedule.

Appendix A

Implementation Task Descriptions

1.0 SYSTEM DESIGN

1.1 Establish Project Management Team

If one was not already established during the earlier phases of the program, a project management team should be assembled at the start of system design. This provides a means of ensuring that all internal stakeholders in the agency will remain appropriately informed and involved in the system design, testing and installation. Identifying responsibilities in advance of contract start will ensure that the agency can properly respond to contractor requests for information and have the opportunity for authoritative review of design submittals.

1.2 Prepare System Description

The System Description describes the fare collection system that the agency has decided to procure and implement. It is an internal document to which all departments may refer to understand fare policy, fare media, equipment functions and physical characteristics, system operation, and departmental responsibilities.

1.3 Identify System Requirements

The system requirements identify in detail the quantities of particular items that will be required for the planned fare collection system. This is also an opportunity to identify the resources required to support procurement and implementation of the system and preparation of agency assets to accommodate the equipment. Identifying these requirements enables the agency to prepare for and budget for the procurement as well as the system itself. System requirements may be included in the System Description document.

1.3.1 Contract Items

A detailed itemized list of all items to be provided by the selected Contractor of the fare collection system is prepared. This list includes types and quantities of equipment and spare components, and non-recurring costs associated with engineering, project management, and software development and licensing, and installation and testing.

1.3.2 Agency Requirements

The fare collection system project will require agency staff time and technical services support during system design and procurement. These required resources need to be identified to ensure that all departments and other stakeholders are able to provide necessary input to the design and are able to respond to Contractor requests in a timely manner.

1.3.3 Third-Party Contractual Requirements

A new fare collection system may require advance preparation of agency vehicles or facilities to accommodate the installation of new equipment. In some instances, the fare collection system will interface with other system which themselves may require modification. Examples of these

systems are on-board smart bus systems, maintenance management and part inventory systems and agency finance and accounting systems.

1.4 Identify Procurement Method

The agency may opt for one of several methods to procure the fare collection system. These include a single-step low bid, a two-step low bid or a negotiated procurement (sometimes called a competitive negotiation, “best value,” or a “best bid”). The method selected will be influenced by state requirements and agency policy as well as the nature of the procurement. A single-step low bid is best for well-defined commodity purchases in which the equipment and system are readily available from several reputable suppliers. The two-step process enables the agency to review technical proposals and contractor qualifications prior to inviting bids from those contractors who are determined to be qualified and then awarding to the lowest. The negotiated procurement enables the agency to consider technical approach, contractor qualifications and proposed price simultaneously. When utilized for more complex systems, it gives contractors the latitude to respond to functional specifications with their own approaches. The agency can then consider the merits of the proposed approach as well as the price and select what it considers to be the best proposal overall, even if it may entail a higher price.

1.5 Update Preliminary Program Cost Estimate

Preliminary cost estimates will have been developed in earlier phases of the project to support evaluation of system alternatives and selection of the system to procure. Completion of the system description document and identification of associated system requirements provides more up-to-date and detailed information for developing a more accurate cost for the system itself and the program overall.

1.5.1 Fare System Contract

The preliminary cost estimate for the system itself is updated to reflect the latest details of the system.

1.5.2 Agency Requirements

A cost estimate of the staff time and materials required to support design and procurement of the project is developed or updated. Any work undertaken by agency personnel to prepare facilities, vehicles and systems for fare collection system installation will also be included in the estimate.

1.5.3 Third-Party Costs

Costs associated with any work that will be required of third parties will be estimated. These costs will be intended to cover any separate contracts that are let to modify agency facilities, vehicles or existing systems to accommodate or interface with the new fare collection system.

1.6 Secure Program Funding

Ideally, funding for the overall program and the system itself will have been secured in advance of the system analysis phase itself. With the system now having been adopted and further defined, this is an opportunity time to review and revise the early estimate, ensure that sufficient funding is in place and if necessary, adjust the funding levels. Limitations on available funding may, on the other hand, require a revision to the planned fare collection system.

2.0 SOLICITATION AND CONTRACT DOCUMENT PREPARATION

2.1 Develop System Activation Schedule

With a good understanding of the both the system and other agency and 3rd party activities required to support the system procurement and installation, a system activation plan and schedule needs to be prepared. The contract-related activities are included in the contract documents representing milestones that must be met by the contractor. Other milestones are identified that must be met by the agency and others to enable the contractor to meet the contract milestones.

2.2 Prepare Contract Documents

With the agency having a clear idea of the fare collection system it wants to procure, a scope of work/technical specification and associated solicitation and contract documents are prepared. The documents identify to prospective contractors the system that is to be installed and the obligations that the contractor must fulfill during every phase of the procurement process. Clarity and thoroughness of these documents are critically important to the ultimate success of the program.

2.2.1 Prepare Scope of Work and System Technical Specifications

The scope of work and technical specifications must clearly communicate to prospective contractors and then to the successful contractor the requirements of the fare collection system and the total scope of work to be performed. Clarity, conciseness and thoroughness are critical to avoid errors, omissions and ambiguity that can result in disputes which may lead to costly delay. The level of detail in a technical specification may vary from a description of functional requirements to specific details of design. In either case, design detail is often warranted to provide a clear definition of interfaces with facilities, vehicles and other systems, and in many cases, with personnel and patrons.

2.2.2 Prepare Technical Drawings and Reference Documents

Technical drawings are often required to support the text of the technical specification itself. Often the most critical drawings are those identifying the locations for equipment installation and associated detail regarding power and communications hook-ups. Other drawings may be provided to identify other necessary interfaces, including design details for personnel and patron interfaces. Reference documents (documents not prepared specifically for the contract) may be included to clarify interfaces with facilities and other systems.

2.2.3 Prepare Terms and Conditions

Terms and conditions identify agency expectations first of the prospective contractors (i.e., those who are bidding or proposing for the contract) and then of the selected contractor who signs a contract to provide the system. The terms and conditions define the selection process and how to submit a bid or proposal. The “Ts & Cs” then define what will be required of the selected contractor regarding contract management, including correspondence, reports, invoicing, dispute resolution, change orders, and project schedule. Legal requirements may require company certifications that are required with the proposal as a condition of responsiveness and which are enforced throughout the contract.

2.2.4 Prepare Solicitation Documents and Submittal Forms

A solicitation document is used to invite parties to participate in the procurement. This document provides a basic explanation of the equipment and services being procured, general information about the procurement (such as schedules, contact information, etc.), protest procedures, the procurement method selected, and the evaluation criteria. In addition, detailed instructions to the proposers (or bidders) are provided in this document. The type of solicitation document reflects the chosen procurement method, and may be structured as an Invitation to Bid (one-step bid process), A Request for Expression of Interest or Request for Qualifications (two-step), or a Request for Proposals (negotiated procurement).

Price proposal or bid forms are prepared for submittal by the proposer (or bidder). These will typically be formulated for the proposer to identify unit and total price by type of equipment, with separate line items for non-recurring engineering and project management costs. Properly structuring the price form can support any necessary price analysis and possible future adjustments to unit price with technical change orders or total price with quantity adjustments. The type of procurement will determine if the price or bid form is required with the initial submittal or, as in a two-step process, following a review of qualifications. The completed price or bid sheets and other mandated certification forms become part of the executed contract.

2.3 Review Scope of Work Documents

As the contract documents are being prepared, the agency will benefit from a series of reviews of the technical specifications and description of the scope of work to be performed.

2.3.1 Conduct Internal Agency Review

Technical reviews are the best means of ensuring that the specification reflects the expectations of the agency's several departments which will be affected by the new system and which therefore have a stake in its design.

2.3.2 Conduct Industry Specification Review

In cases where a system design is based on the implementation of new technology, the agency may benefit from a review by prospective suppliers. This gives the suppliers an opportunity to provide suggestions and comment that enable the agency to ensure that the specification will promote competitive bidding with systems that will meet their requirements. Many agencies request a review of the specification by experienced personnel at other agencies. These personnel are often able to share the lessons learned from their recent experiences of a similar fare collection system procurement.

2.4 Prepare Final Engineer's Cost Estimate

When the specification and associated contract documents are complete, a final cost estimate, the "Final Engineer's Cost Estimate" is prepared. This reflects the expectations concerning price of those that prepared the scope of work and associated terms and conditions. It is a yard stick for measuring the prices proposals that are received.

3.0 SYSTEM PROCUREMENT

With the completion of system design and of the contract documents, the next phase is to solicit bids or proposals and then following a selection process, award the contract to the contractor that best meets the selection criteria established in advance by the agency.

3.1 Solicit Proposals

Solicitation of proposals may include the following:

- Advance notice to known fare collection suppliers of a forthcoming solicitation
- Advertisement and distribution of the solicitation of those requesting copies of the solicitation package
- Pre-proposal or pre-bid meeting with possible tour of facilities
- Response to requests for clarification or information
- Amendments to the contract documents as necessary based on comments received

3.2 Select Contractor

The selection process depends upon the selection method. Any technical review of proposals is typically undertaken by an evaluation committee composed of agency representatives who are most directly involved in the procurement or who will be most directly involved in its operation. Other individuals from the agency, supporting consultants and other transit agencies may be assigned to review technical proposals (either in their entirety or specific sections) and advise the committee on their findings. The conclusions of the evaluation committee will be used to qualify bidding contractors in a two-step procurement or to rate and rank proposing contractors in a negotiated procurement. Price proposals are typically not revealed until after completion of the technical evaluation. They are then applied to a pre-approved formula that along with the technical rating positions the proposals according to overall value. In a negotiated procurement, the agency may opt to interview each firm submitting a proposal and then, following possible amendments to the contract documents, request a “best and final offer”. The revised proposals are then evaluated, rated and then with the BAFO price rated for final selection by the agency. The evaluation and selection process should follow a prepared set of detailed procedures to expedite the process and avoid conflict, confusion and risk of protest.

3.3 Award Contract

Following the evaluation and selection process, the agency selects the contractor that best meets its selection criteria. The award process then follows those procedures that are policy to the particular agency. These may include approval of the pending award by the Board of Directors. Contract negotiations are concluded prior to the signing of the contract and issuance of a notice to proceed. In some cases, Board approval of the negotiated contract is also required.

4.0 DESIGN AND TEST

With the contractor now under contract to provide a fare collection system, the first phase of the contract typically involves the contractor design of the system. The design follows the technical specifications that were developed by the agency. The contractor provides design documentation that confirms an understanding of the design and provides, with timely agency input, necessary design details.

4.1 Oversee System Design

During the design and test phase of the contract, the agency project manager (PM) will be responsible for all correspondence with the contractor. The PM will also ensure that all material received from the contractor is routed appropriately for expeditious response. (Delays in responding to the contractor may be grounds for contract delay at a later point in the contract.) Electronic distribution of documents via e-mail, CD-ROM and FTP web site has become a valuable tool in this regard.

The PM is responsible for resolving open issues, coordinating program-related activity, including action items and task assignments, enforcing the terms of the contract (with support of the contract administrator), initiating change notices and change orders, and keeping the program to schedule and within budget.

4.2 Conduct Conceptual, Preliminary and Final Design Reviews

During this phase of the contract, the contractor will issue technical submittals in accordance with the requirements of the contract. The design reviews of these documents are key milestones in the contract. Agency representatives assigned by the project manager working with the project management team review the design submittals. Approval of the Design Review Milestones gives the contractor authority to proceed with further development of the design and to proceed with the purchase of material and assemblies required for manufacture of the equipment. Approval of final design enables the contractor to move to production of equipment and full development of systems software.

4.3 Evaluate Prototype and/or First Article (Pre-Production) Device(s)

A prototype enables the agency to see both how the equipment will function and how well the design and layout of the equipment will support convenient operation by patrons and operation and maintenance by personnel. Evaluated as part of the system design process, the lessons learned from the prototype can then be incorporated into the final design of the equipment, with respect to operability and maintainability. Focus groups of line personnel and riders can assist in assessing equipment and systems design.

4.4 Witness Pre-production Testing and Approve Production

First Article units are those that are produced by the set production line. Testing these units and the system software gives the agency an opportunity to confirm that the production units and the system are as approved in final design. These units may be subject to a battery of tests to confirm that all aspects of the specification are met. These tests may be held at the contractor facilities or on-site. With successful completion of these tests, approval for full production can be issued.

5.0 INSTALLATION, TEST AND ACCEPTANCE

With approval for equipment production, the fare collection contract moves from the “design, and test,” phase to the “installation, test and acceptance” phase. During equipment production, factory Quality Assurance testing will be conducted by the contractor. The agency may opt to witness a representative sampling of this production testing. Factory production testing should be successfully completed and documented before the equipment is shipped.

5.1 Prepare Vehicles and Facilities for Installation of Equipment

Earlier in the program, development of system requirements identified what would be needed to accommodate installation of the new fare collection system. Prior to the installation of any equipment, the installation sites will need to be prepared – whether on vehicle or in a station or other facility. The contract scope of work should be very clear on the work to be performed by the contractor and that which is to be performed by the agency or a third party under separate contract to the agency.

5.2 Conduct Pilot Installation Tests

Prior to approval for full installation of the fare collection system, it is sometimes prudent to conduct a test of a representative portion of the system. The initial shipments of equipment are installed at the prepared pilot installation sites and any required communications are connected to enable a thorough testing of all elements of the system on this smaller scale. (Depending on the scale of the test, a demonstration test or a “beta” test may be conducted instead of or in addition to pilot station or pilot garage test. This typically entails a number of sites or vehicles being equipped to test in revenue service what will ultimately be a system-wide deployment.)

5.3 Install and Test All Equipment

With the satisfactory completion of pilot station or garage testing (and/or demonstration testing), the contractor is then authorized to proceed with the manufacture and installation of the entire system. Each unit of installed equipment undergoes rigorous testing as a unit and as a component of the overall system to ensure its satisfactory operation.

5.4 Conduct Post-Revenue Acceptance Testing

Following successful system start-up, testing continues in revenue service to verify that the equipment individually and the system overall meet all performance requirements concerning reliability, maintainability and accuracy. Careful definition of these measures during specification development is critical to successfully conducting these tests without dispute between agency and contractor. The warranty period may in some cases be defined to start only after the reliability, maintainability and accuracy testing has successfully concluded.

6.0 BOARD ACTION AND PUBLIC REVIEW

Any action required of the Board of Directors must be identified early in the program as this can often take a considerable amount of time. In most agencies, Boards meet monthly. There exist deadlines for placing an item first on the agenda of a Board committee meeting and then of the Board meeting with

requirements for advanced issue of Board Reports. In addition to approving Contract award to the recommended contractor, there may be several other items requiring Board action.

6.1 Approve Fare Revisions

If revisions to fare policy are planned concurrent to implementation of the new fare collection system, public hearings and Board approval are typically required

6.2 Adopt Policy Changes and/or Agency Regulations and Ordinances

Changes in the method of fare collection and enforcement regulations may require Board action. This is particularly true of fare collection systems that implement a proof-of-payment fare collection system. In several cases, agencies required new regulations and ordinances empowering civilian employees (i.e., personnel other than sworn peace officers) to issue citations to patrons who cannot show valid proof-of-payment to a fare inspector. Board action may also be required to establish an internal adjudication board to review fare violations that are contested.

7.0 EDUCATION AND AWARENESS

Education of those who will be affected by the new fare collection system is critical to its successful implementation. This is especially important if the new system or equipment is substantially different from the system or equipment it replaces.

7.1 Educate the Public

A public education program can inform the public in general and patrons in particular of the changes and show them how the system will be used in the future. Seat flyer and car cards on the vehicles, notices in stations and at bus stops, and printed, radio and TV media can further inform the public.

7.2 Educate Agency Personnel

All personnel within the agency should be informed of the changes that will take place to the fare collection system. Most personnel – those who need to operate and maintain the system – will receive focused training. A general education process is also appropriate for those in other departments with little or no fare collection responsibilities

7.3 Educate Third-Party Stakeholders

Many organizations outside of the agency itself may have a stake in how fares are collected. These may include local municipal officials; schools and social service agencies that rely heavily on transit service; employers taking advantage of the agency's transit benefits (employer pass) program. A targeted education program will ensure that each group is aware of and prepared for the changes to come with implementation of the new fare collection system.

8.0 PROOF-OF-PAYMENT IMPLEMENTATION

Some new fare collection systems entail implementation of proof-of-payment method of ensuring that patrons have paid the correct fare for their travel. This relies more on inspection and court enforcement than on system equipment, and thus requires that the agency have the authority and procedures in place ensure that enforcement will be upheld.

8.1 Establish Enforcement Authority

Proof-of-payment fare collection relies on manual inspection of fares by a designated class of personnel, who may be sworn peace officers or specially empowered civilian employees of the agency. They require the authority to inspect tickets and passes and to cite fare violators.

8.1.1 Create Legislation to Revise State Code, if Necessary

State codes typically make it a crime to avoid payment of the proper fare on a transit vehicle. These laws enable a vehicle operator to summon police to cite or arrest those attempting to ride without paying fare. Additional legislation and other ordinances or regulations are often necessary to support proper establishment of a proof-of-payment system. These may include authority for civilian agency personnel to inspect and cite passengers who fail to produce a valid ticket or pass. Legislation may also be required to establish a more appropriate level of violation and penalty for fare evasion than that currently on the books.

8.1.2 Establish Regulations via Board Action

Following the passage of legislation amending the state criminal code, the agency Board of Director may be obligated to establish regulations naming the specific personnel positions that are authorized to inspect and cite. The action required of the Board may vary from state to state.

8.1.3 Establish POP Protocols with Judicial and Law Enforcement

The proof-of-payment system may rely heavily on the support of the municipal court system and on law enforcement to ensure that fare evasion violators are made to pay the fines that are the penalty. It is critical to the success of the proof-of-payment concept that the agency secures the cooperation of these agencies. They need to work together to establish protocols for citing, processing and fining violators.

8.2 Establish Inspection Policy

As a new function of the agency, whether assigned to transit police, revenue or operations, or whether assigned to an outside agency, fare inspection policy must first be established. These include: frequency of inspection, hours of inspection; inspection strategy and the degree of discretion given the fare inspectors for citing or simply warning fare violators.

8.3 Organize Violation Processing

8.3.1 Set Up Adjudication Process (Internal or Judicial)

Processing of violations may entail an internal or judicial process of adjudication, in which citations are processed and fines are collected. Contested citations are reviewed.

8.3.2 Create Tracking System

A system for tracking citations issued and processed and the final disposition of each violation will enable the agency to track any fine revenue that is due the agency and to maintain a hot list of riders who are either repeat violators or who have outstanding warrants or unpaid citations.

9.0 AGENCY PREPARATION

Agency preparations include budgeting, recruitment, hiring and training of personnel, development of procedures and procurement of material and support equipment needed for operation and maintenance of the system. These basic requirements are the same for each department that will have a fare collection related function, although the specific needs of personnel may differ.

9.1 Operations

9.1.1 Budget for Personnel and Materials

Each department needs to take into account the annual budgeting process when timing its budget requests for staffing and materials. Timing for recruitment and hiring needs to consider the time required for training and possible support of testing prior to system commissioning.

9.1.2 Recruit and Hire Personnel

The need for new personnel will depend upon the type of system being put in place and the extent to which it differs from the existing one. Quite often there will be no need to hire new vehicle operators. There may, however, be a need to hire new station attendant personnel or to eliminate the jobs of existing station personnel and to reassign the employees in those positions. Labor agreements can influence personnel decisions. If positions are eliminated, 13C labor issues may need to be addressed.

9.1.3 Prepare/Revise Operating Procedures

Implementation of a new fare collection system may require the development of new operating procedures or the revision of existing ones concerning operation of equipment and how to deal with situations concerning problems or disputes arising from use of the system.

9.1.4 Train Personnel

Training for operations personnel will typically involve first having the contractor train supervisory personnel and those who will in turn train the line personnel, such as vehicle operators and station personnel. The trainers will then be responsible for training the line personnel. The department management may augment the contractor provided training with in-house training of operating procedures that were not part of the contractor's obligations.

9.2 Maintenance

9.2.1 Budget for Personnel and Materials

The number of personnel required to maintain fare collection systems will depend upon anticipated levels of required preventive and corrective maintenance, operating hours per day, distance to travel from the maintenance facility, the required availability rates, etc. The warranty period may reduce the cost and time required for component repairs but will not reduce the effort associated with field maintenance, troubleshooting and repairs. Some agencies opt to outsource maintenance duties either to the contractor or a third party.

9.2.2 Recruit and Hire Personnel

A new fare collection system that involves new or more equipment may require new or additional maintenance personnel to keep the equipment in reliable working condition. The agency may opt instead to contract for maintenance and servicing by the contractor, in line with a prevailing policy of the agency to outsource where possible. An economic analysis can determine which approach is the more economic.

9.2.3 Establish Maintenance Operating Procedures

The contractor will be obligated to supply operator and maintenance manuals, as-built drawings and training materials as part of the contract. These documents will help the department responsible for equipment maintenance develop new or revised maintenance procedures for maintaining and servicing the equipment. The department will augment the contractor supplied with procedures for reporting and logging failures and maintenance activity.

9.2.4 Train Personnel

Maintenance personnel will receive first contract-supplied training on the operation and maintenance of the system and its equipment, and then departmental training on in-house procedures for reporting and repairing the equipment

9.2.5 Establish Inventory Control for New Parts and Material

The maintenance department is often responsible for inventory control of the parts and material required to keep the system working order. Spare parts and repairable/reusable components will typically get logged into the existing parts control system. A supply of consumable materials needed for equipment preventive maintenance is kept in stock.

9.2.6 Provide Personnel Equipment and Special Tools

The maintenance department and its maintenance personnel will require appropriate tools and other maintenance equipment to repair and test failed components and equipment. The contractor is typically required in the procurement contract to provide a list of tools that are required for maintenance and to supply any special tools and test equipment that will be needed.

9.2.7 Prepare Shop for New Repair and Test Equipment

If the agency does opt to perform maintenance and servicing in-house, then the maintenance department should consider setting up a test bench. This test bench (or station) should utilize production equipment identical to that which is installed and in revenue service. The primary purposes of this test equipment will be to confirm functionality of repaired modules before

returning them to service, and to test new software and configuration settings before propagating them to the in-service equipment.

9.2.8 *Develop Management Reporting System*

Typically, the maintenance department will have a maintenance management reporting system in place. If not and one is not being provided by the fare collection contractor, the agency should consider developing or purchasing one. This will improve the ability of the maintenance department to effectively track preventive maintenance schedules and equipment repairs, enabling the department to improve its maintenance effectiveness and efficiency.

9.3 *Marketing and Customer Service*

9.3.1 *Budget for Personnel and Materials*

9.3.2 *Recruit and Hire Personnel*

Here again, the fare collection system will determine the need for additional personnel for customer service. Implementation of a smart card program may require new personnel to administer the program which will entail the creation, distribution, registering and processing of distributed personnel smart cards.

9.3.3 *Prepare Procedures for Customer Service*

Procedures for customer service may need to be developed and existing ones revised. This will be particularly true if a new fare collection system with new media is being implemented. Procedures may include the sale of tickets and passes, refund policy, and distribution and registering of smart cards.

9.3.4 *Train Personnel*

Customer service personnel should receive contractor-supplied training on any new equipment that will be installed for operation by customer service personnel. They will also receive in-house training on the new or revised procedures for ticket sale, refunds, and handling disputes.

9.3.5 *Develop or Revise Corporate Pass Program*

If the agency has a transit benefits corporate pass program, the new fare collection system may be designed to help streamline the manner in which it is administered. Introduction of electronic fare media such as smart cards can eliminate the need to distribute farecards on a monthly basis, allowing instead the establishment of an account-based system that autoloads the smart card each month.

9.4 *Revenue*

9.4.1 *Budget for Personnel and Materials*

9.4.2 *Recruit and Hire Personnel*

The Revenue Department may need to hire new personnel or to reassign personnel for the new system. The personnel responsibilities may include the servicing of fare collection equipment; that is, the emptying of revenue from cashboxes and refill of change supply and tickets in those equipment units that are designed to do that. Some agencies opt to outsource this revenue servicing of ticket vending machines to armored car services, if security of personnel and equipment is a concern.

9.4.3 Prepare Operating Procedures and Service Schedule

The Revenue Department may need to prepare operating procedures or revise existing ones to accommodate the particular needs of the new fare collection system, which may involve the implementation a new means of emptying cashboxes and of reporting revenue and sales. If it is among their duties, procedures for refunds and charge-backs may need to be prepared.

9.4.4 Train Personnel

Personnel will receive training from the contractor on operation and revenue servicing of new equipment.

9.4.5 Provide Revenue Servicing Equipment

A new fare collection system may in turn require use of new revenue transport equipment and/or of new equipment at the cash counting facility for the processing of revenue.

9.4.6 Develop Revenue Reporting System

If not provided by the contractor, a new revenue reporting system may be of value to the agency to better report on revenue and sales, taking advantage of the data that can be logged today. Existing revenue reporting systems may gain from enhancements to the memory of each unit of equipment.

9.4.7 Develop Fare Media Transition and Distribution Plan

Introduction of new fare media and fare processors may make existing farecards obsolete. Implementation of the new system may require a plan for phasing out old fare media as the new fare media is introduced. This will need to be done in a manner that passengers with previously purchased farecards do not lose any of the value on the card. A plan may also be required for encoding, distributing and registering smart cards.

9.5 Information Technology

9.5.1 Budget for Personnel and Materials

9.5.2 Recruit and Hire Personnel

The information technology department may be assigned the responsibility of maintaining the computers and associated software of the new fare collection. Duties may also entail input of fare tables, modification of instructional passenger display screens. Input of temporary special fares may also be part of the department duties. New or revised reports may need to be developed for use by the system end-users such as revenue, accounting, police/fare inspection, and customer service and maintenance.

9.5.3 Train Personnel

The contractor will train the IT personnel on operation of the system and maintenance of the central computer and the application software and reports.

9.5.4 Prepare Operating and Maintenance Procedures

With properly trained IT personnel, set procedures will provide necessary guidance and security protocols for developing and implementing updates to the sophisticated software and database tools reside on the equipment and that can comprise a central control or monitoring system. New or revised software should be fully tested prior to full system installation.

9.6 Police/Security

This implementation plan differentiates between police duties and fare inspection responsibilities. It also treats fare inspection as an internal agency function. In many cases, fare inspection is a responsibility of the police department whether this is an internal department or a municipal one.

9.6.1 Budget for Personnel and Materials

9.6.2 Recruit and Hire Personnel

A change in fare collection methods may affect the number of sworn officers and security guards that are required on the transit property. A change to a more automated system or to a proof-of-payment may require an increase in police presence to enforce proper use of the system, to protect property and equipment installed at unattended locations and to respond to calls for assistance by civilian fare inspectors. The agency may opt to use security guards to escort revenue crews to the field to service ticket vending machines in unattended stations.

9.6.3 Prepare Security Procedures and Key Control

Under the circumstances described in the previous section, new procedures may be required or existing ones may require update. An internal police department may also be responsible for key control of the many keys that may be distributed for internal access to revenue handling equipment, their cashboxes and hoppers, and to the facilities that house cash or ticket media facilities.

9.6.4 Train Personnel

Personnel responsible for providing security and protection of personnel, riders, revenue, and agency property will receive training on responsibilities and the procedures outlined above.

9.7 Fare Enforcement

Implementation of a proof-of-payment system creates an entirely new set of responsibilities, with new personnel, procedures, training and material.

9.7.1 Budget for Personnel and Materials

9.7.2 Recruit and Hire Personnel

The approach to fare inspection in a proof-of-payment fare collection system must be identified early in the program. If sworn officers are to be responsible for fare inspection and additional officers are required, there is a long-lead time for recruiting and training these officers – typically as long as two years of recruitment and academy training. Recruitment and hiring of civilian personnel will not require this much time, although the hiring process must take care to ensure that those who are hired are capable of approaching passengers on a routine basis to ask for and inspect tickets and passes in a non-threatening manner and to be prepared to deal with those who might not respond well to this request.

As a new class of personnel, job descriptions will need to be prepared for fare inspectors and inspection supervisors.

9.7.3 Prepare Inspection Policy and Methods Procedures

Rules and procedures will be required to clearly describe how fares will be conducted. They should define the following:

- How and when to board a vehicle, with one, two or more inspectors
- How and where to commence inspections
- How to inspect fare media visually
- What to do when a rider without fare media
- What to do when the fare media presented has expired or is not the correct fare
- What to do if the fare media appears to be altered or defaced
- What to do if the rider refuses to show fare or is otherwise belligerent and not cooperative
- How to prepare a citation (or Notice of Violation or summons) for failure to pay fare
- When to end inspections
- How to process citations
- Personnel behavior on duty and when in uniform off-duty
- How to confirm a claim of faulty fare collection equipment that prevented the rider from purchasing a fare

9.7.4 Train Personnel

Inspection personnel will typically be trained by both the contractor and by agency personnel. Use of special equipment, such as hand-held card readers (to display information encoded on smart cards and/or magnetic farecards) will be provided by the contractor. In-house training will be provided on inspection policy and methods, and procedures for citing and reporting fare violators and reporting daily activity. Given the nature of a new proof-of-payment system, a simulation of fare inspection and processing activities prior to full implementation may help give the personnel helpful experience and enable the agency and its cooperating agencies (courts and law enforcement) to work out any kinks.

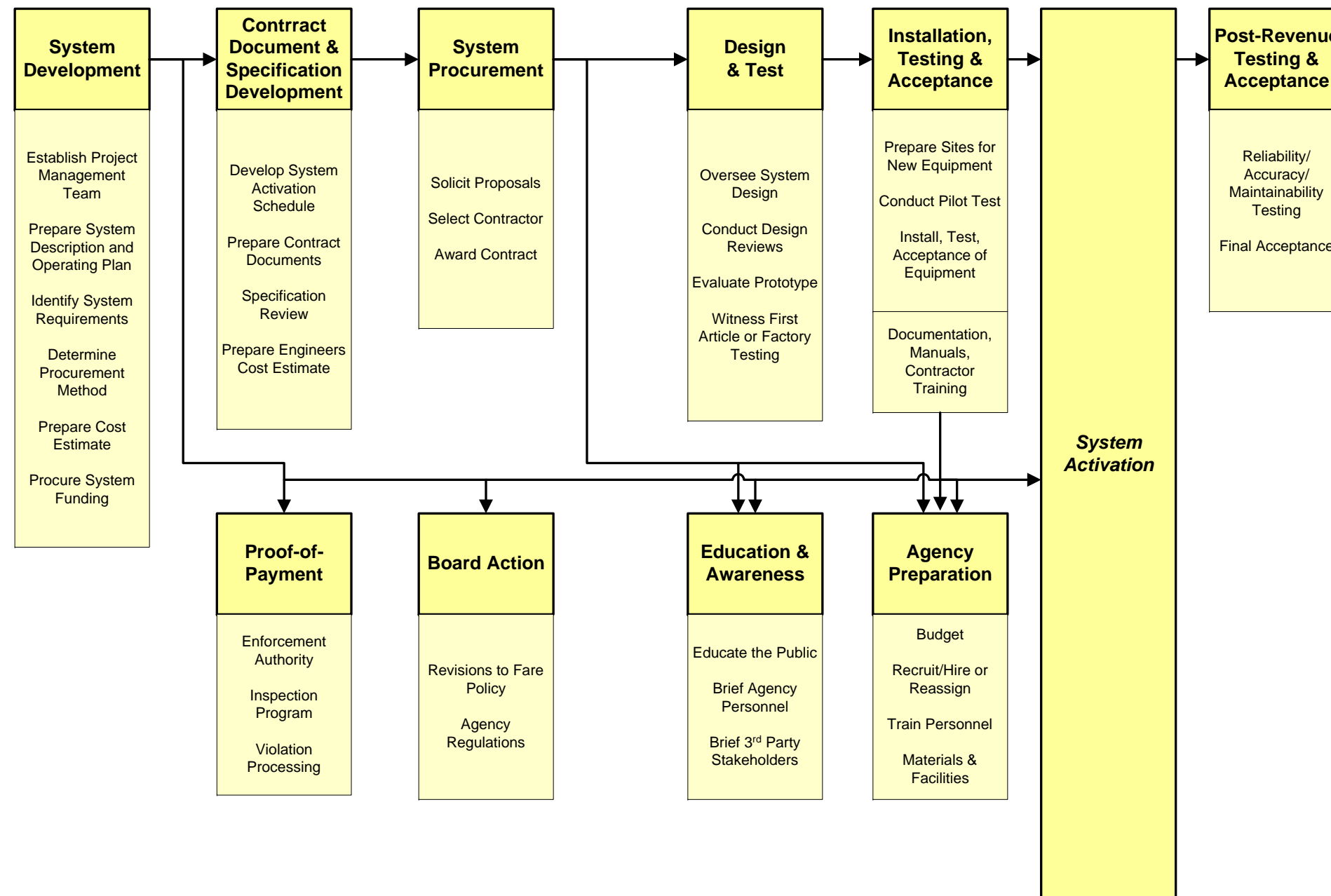
9.7.5 Provide Uniforms and Gear, Facilities

As a new class with newly hired personnel, uniforms will need to be designed and procured. Notice of Violation forms may be required if the standard forms for infraction or misdemeanor cannot be used. Badges or other means of identification may need to be procured and distributed.

Radios will be required along with the hand-held card readers that may be provided as part of the fare collection contract. Lockers and nominal workspace may also be required.

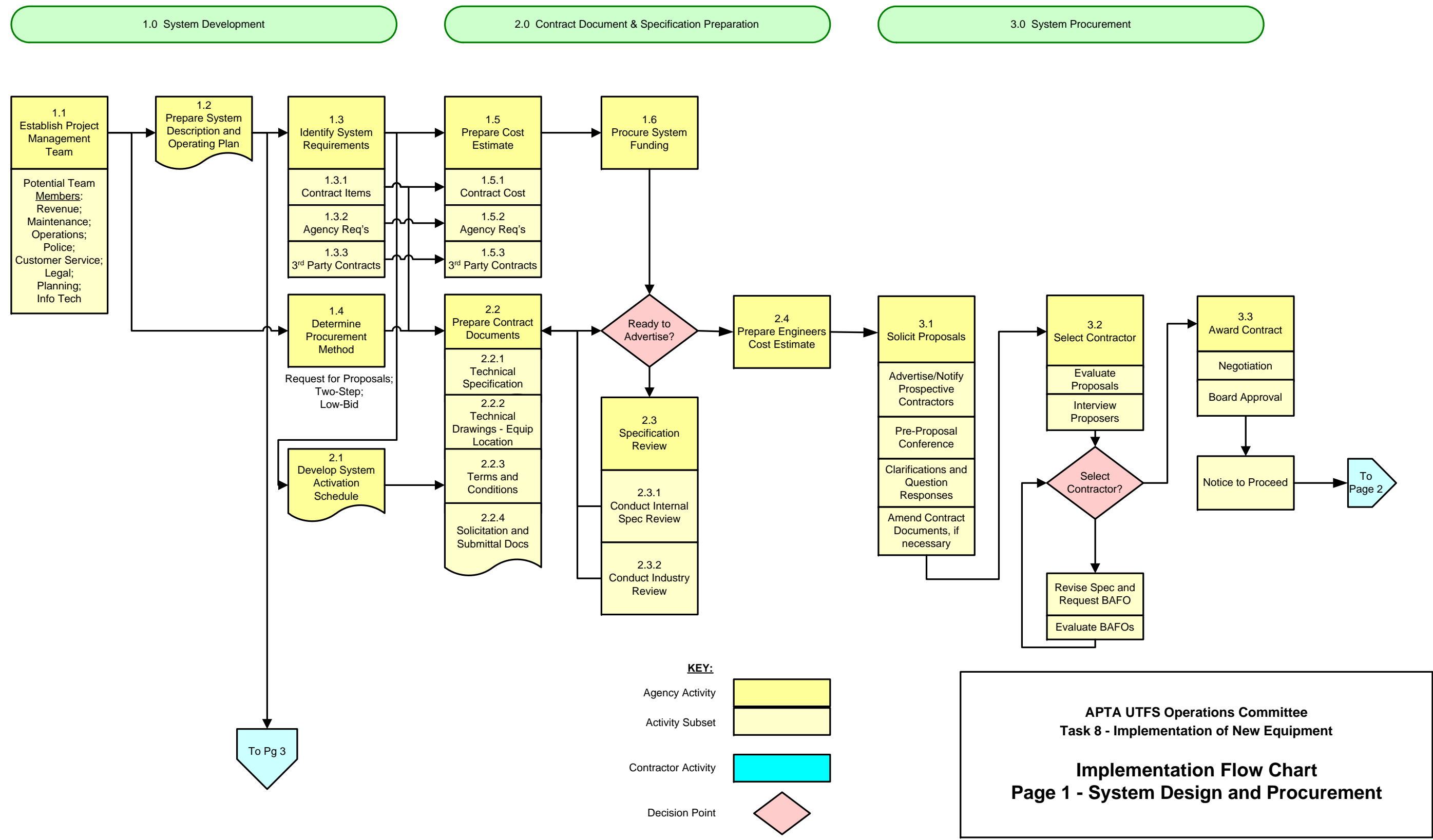
Appendix B

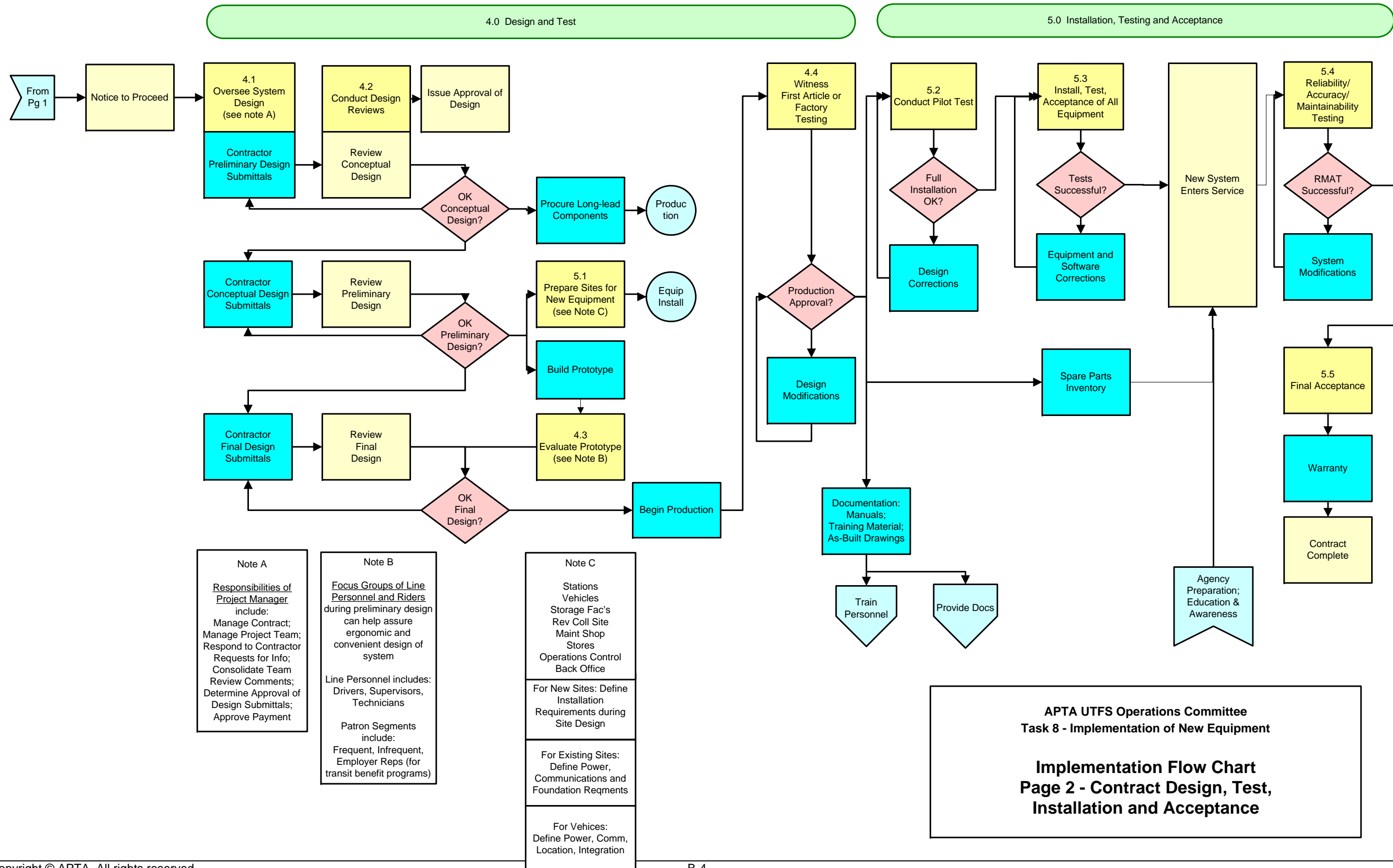
Implementation Flow Chart

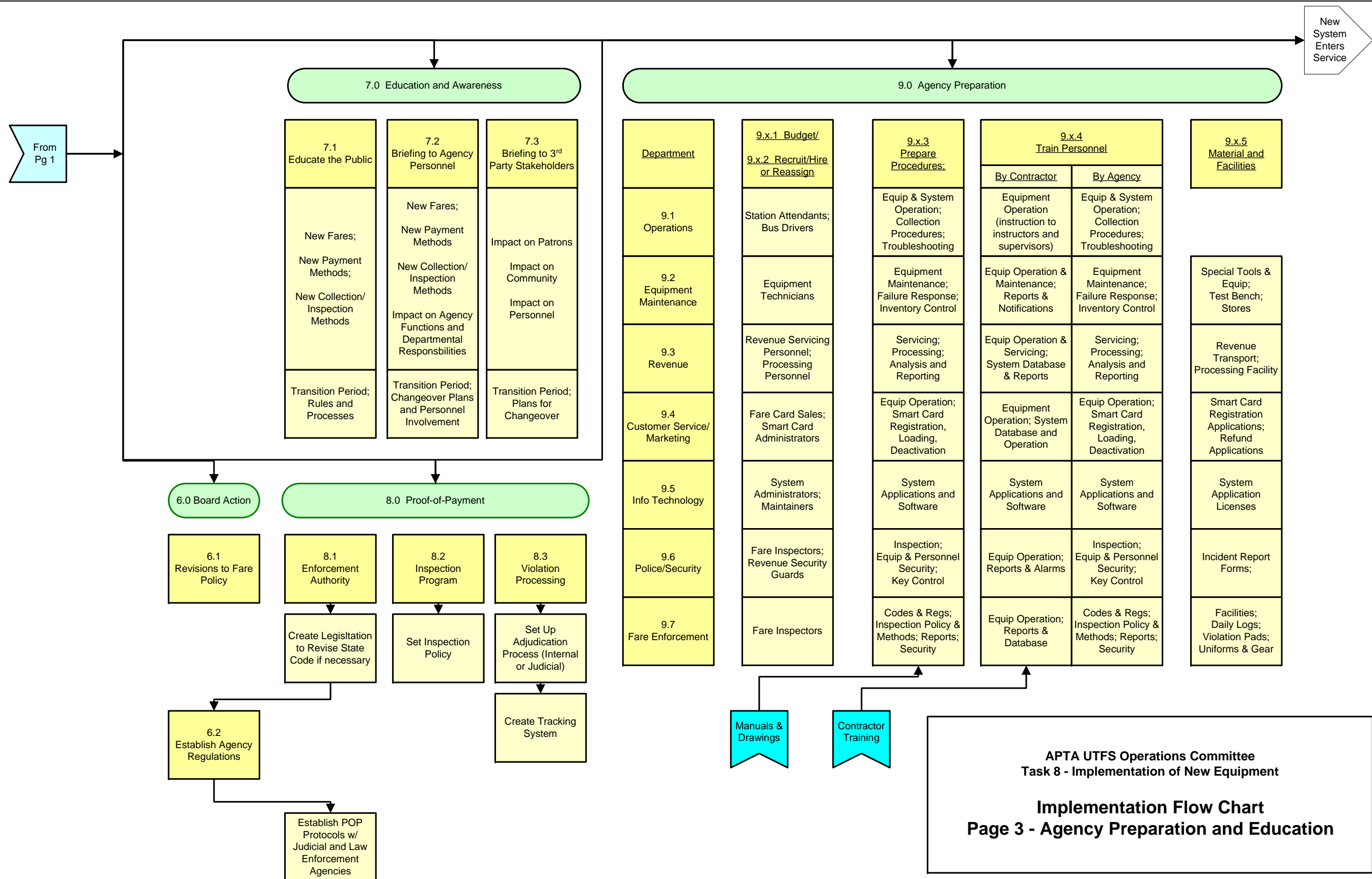


APTA UTFS Operations Committee
Task 8 - Implementation of New Equipment

**Implementation Flow Chart
Process Overview**







Appendix C

Implementation Task Checklist

Implementation Task Checklist

Reference	Task Group	Responsible Lead		Task Sequence		Completion Schedule			Task Status	Exec Mgt Team	Project Manager	Operations	Veh Maint	Fac Maint	Revenue	Marketing	Police	Engineering	Procurement	Info Systems	Legal	Budget	Empl Rel	Training
		Individual	Department	Prerequisite to this Task	Dependent on this Task	Start	End	Duration																
P:Primary; S: Support; R: Review; A: Approve																								
1.0	System Design																							
1.1	Establish Project Management Team		Project Manager																					
1.2	Prepare System Description		Project Manager		Identify System Requirements; Determine Procurement Method																			
1.3	Identify System Requirements				Prepare Cost Estimate for Project																			
1.3.1	Contract Items		Project Manager	Prepare System Description	Estimate Contract Cost																			
1.3.2	Agency Requirements		Project Manager	Prepare System Description	Estimate Agency Costs																			
1.3.3	Third-Party Contractual Requirements		Project Manager	Prepare System Description	Estimate 3rd Party Contracts Costs																			
1.4	Identify Procurement Method		Procurement		Prepare Contract Documents																			
1.5	Prepare Cost Estimates				Secure System Funding																			
1.5.1	Fare System Contract		Project Manager	ID System Requirements																				
1.5.2	Agency Requirements		Project Manager	ID System Requirements																				
1.5.3	3rd Party Costs		Project Manager	ID System Requirements																				
1.6	Secure System Funding		Grants	Prepare Cost Estimate	Engineer Cost Est; Solicit Proposals																			
2.0	Contract Document and Specification Preparation																							
2.1	Develop System Activation Schedule		Project Manager	Prepare System Description	Specification Preparation																			
2.2	Develop Contract Documents for Procurement				Specification Reviews; Solicit Proposals																			
2.2.1	Prepare System Technical Specifications		Project Manager	Prepare System Description																				
2.2.2	Prepare Technical Drawings for Equipment Locations		Project Manager	Prepare System Description																				
2.2.3	Prepare Term and Conditions for RFP		Procurement	Prepare System Description																				
2.2.4	Develop Solicitation and Submittal Documents		Procurement	Prepare System Description	Solicit Proposals																			
2.3	Review Specification Documents			Prepare System Description	Proposals																			
2.3.1	Conduct Internal Agency Specification Review		Project Manager	Prepare System Technical Specifications																				
2.3.2	Conduct Industry Specification review		Project Manager	Conduct Internal Agency Spec Review																				
2.4	Prepare Engineer's Cost Estimate		Project Manager	Conduct Industry Specification Review	Solicit Proposals																			
3.0	System Procurement																							
3.1	Solicit Proposals		Procurement	Prepare Engineers Cost Estimate	Select Contractor																			
3.2	Select Contractor		Project Manager	Solicit Proposals	Award Contract																			
3.3	Award Contract		Project Manager	Select Contractor																				
4.0	Design and Test		Project Manager																					
4.1	Oversee System Design		Project Manager	Award Contract	Design Reviews; Approval of Design																			
4.2	Conduct Conceptual, Preliminary and Final Design Reviews		Project Manager	Award Contract	Design Approval; Testing; Prototype																			
4.3	Evaluate Prototype Equipment		Project Manager	Conduct Design Reviews	Witness First Article or Factory Testing																			
4.4	Witness First Article or Factory Testing		Project Manager	Design Reviews; Design Approval	Equip Production; Install/Test All Equipment																			
5.0	Installation, Test and Acceptance																							
5.1	Prepare Vehicles and Facilities for Installation		Vehicle Maintenance	Reviews	Pilot Test; Install/Test All Equip																			
5.2	Conduct Pilot Test		Project Manager	First Article; Veh/Fac Site Preparation	Install/Test All Equipment																			
5.3	Install and Test All Equipment		Project Manager	Conduct First Article, Pilot Tests	System Enters Service; Post-Rev Testing																			
5.4	Conduct Post-Revenue Acceptance Testing		Project Manager	Install and Test	Warranty; Final Acceptance																			

Implementation Task Checklist

Reference	Task Group	Responsible Lead		Task Sequence		Completion Schedule			Task Status	Exec Mgt Team	Project Manager	Operations	Veh Maint	Fac Maint	Revenue	Marketing	Police	Engineering	Procurement	Info Systems	Legal	Budget	Empl Rel	Training
		Individual	Department	Prerequisite to this Task	Dependent on this Task	Start	End	Duration																
6.0	Board Action and Public review																							
6.1	Approve Fare Revisions following Public Review		Planning	Prepare System Description	System Enters Service																			
6.2	Adopt Policy Changes and/or Agency Regulations and Ordinances		Legal	Prepare System Description	System Enters Service																			
7.0	Education and Awareness																							
7.1	Educate the Public		Marketing	Prepare System Description	System Enters Service																			
7.2	Educate Agency Personnel		Project Manager	Prepare System Description	System Enters Service																			
7.3	Educate Third-Party Stakeholders		Government Affairs	Prepare System Description	System Enters Service																			
8.0	Proof-of-Payment Implementation																							
8.1	Establish Enforcement Authority				Establish Enforcement Policy																			
8.1.1	Create Legislation to Revise State Code, if necessary		Legal	Prepare System Description	Establish Enforcement Policy																			
8.1.2	Establish Regulations via Board Action		Legal	Create Legislation	Establish Enforcement Policy																			
8.1.3	Establish POP Protocols with Judicial and Law Enforcement		Legal	Establish Regulations	Establish Enforcement Policy																			
8.2	Establish Inspection Policy		Fare Enforcement	Establish POP Protocols	Prepare Enforcement Policy and Methods																			
8.3	Organize Violation Processing				System Enters Service																			
8.3.1	Set Up Adjudication Process (Internal or Judicial)		Legal	Establish POP Protocols	System Enters Service																			
8.3.2	Create Tracking System		Fare Enforcement	Establish POP Protocols	System Enters Service																			
9.0	Agency Preparation																							
9.1	Operations																							
9.1.1	Budget for Personnel and Materials		Operations	Prepare System Description	Recruit and Hire Personnel																			
9.1.2	Recruit and Hire Personnel		Operations	Budget	Train Personnel																			
9.1.3	Prepare/Revise Operating Procedures		Operations	Prepare System Description	Train Personnel																			
9.1.4	Train Personnel		Operations	Contractor Manuals	System Enters Service																			
9.2	System Maintenance																							
9.2.1	Budget for Personnel and Materials		Facilities Maintenance	Prepare System Description	Recruit and Hire Personnel																			
9.2.2	Recruit and Hire Personnel		Facilities Maintenance	Budget	Train Personnel																			
9.2.3	Establish Maintenance Operating Procedures		Facilities Maintenance	Contractor Manuals	Train Personnel																			
9.2.4	Train Personnel		Facilities Maintenance	Contractor Manuals	System Enters Service																			
9.2.5	Establish Inventory Control for New Parts and Material		Facilities Maintenance	Parts List (Prelim Design)	System Enters Service																			
9.2.6	Provide Personnel equipment and Special Tools		Facilities Maintenance	Maint Ops Procedures	System Enters Service																			
9.2.7	Prepare Shop for New Repair and Test Equipment		Facilities Maintenance	Preliminary Design	System Enters Service																			
9.2.8	Develop Management Reporting Program		Facilities Maintenance	Preliminary Design	System Enters Service																			

Implementation Task Checklist

Reference	Task Group	Responsible Lead		Task Sequence		Completion Schedule			Task Status	Exec Mgt Team	Project Manager	Operations	Veh Maint	Fac Maint	Revenue	Marketing	Police	Engineering	Procurement	Info Systems	Legal	Budget	Empl Rel	Training
		Individual	Department	Prerequisite to this Task	Dependent on this Task	Start	End	Duration																
9.2.2	Recruit and Hire Personnel		Customer Service	Budget	Train Personnel																			
9.2.3	Prepare Operating Procedures for Customer Service		Customer Service	Contractor Manuals	Train Personnel																			
9.2.4	Train Personnel - Contractor-Taught and Department-Taught		Customer Service	Contractor Manuals	System Enters Service																			
9.2.5	Develop or Revise Corporate Pass Program		Customer Service	Preliminary Design	System Enters Service																			
9.3	Revenue																							
9.3.1	Budget for Personnel and Materials		Revenue/Finance	Prepare System Description	Recruit and Hire Personnel																			
9.3.2	Recruit and Hire Personnel		Revenue/Finance	Budget	Train Personnel																			
9.3.3	Prepare Operating Procedures and Servicing Schedule		Revenue/Finance	Contractor Manuals	Train Personnel																			
9.3.4	Train Personnel		Revenue/Finance	Recruit/Hire; Contractor Manuals	System Enters Service																			
9.3.5	Provide Revenue Servicing Equipment		Revenue/Finance	Preliminary Design	System Enters Service																			
9.3.6	Develop Revenue Reporting System		Revenue/Finance	Preliminary Design	System Enters Service																			
9.3.7	Develop Fare Meida Transition and Distribution Plan		Revenue/Finance	Prepare System Description	System Enters Service																			
9.4	Information Technology																							
9.4.1	Budget for Personnel and Materials		Info Tech/Telecomm	Prepare System Description	Recruit and Hire Personnel																			
9.4.2	Recruit and Hire Personnel		Info Tech/Telecomm	Budget	Train Personnel																			
9.4.3	Train Personnel - Contractor Taught		Info Tech/Telecomm	Contractor Manuals	System Enters Service																			
9.4.4	Prepare Operating and Maintenance Procedures		Info Tech/Telecomm	Recruit/Hire	System Enters Service																			
9.5	Police/Security																							
9.5.1	Budget for Personnel and Materials		Security/Transit Police	Prepare System Description	System Enters Service																			
9.5.2	Recruit and Hire Personnel		Security/Transit Police	Budget	System Enters Service																			
9.5.3	Train Personnel		Security/Transit Police	Contractor Manuals	System Enters Service																			
9.5.4	Prepare Security Procedures and Key Control		Security/Transit Police	Prepare System Description	System Enters Service																			
9.6	Fare Enforcement																							
9.6.1	Budget for Personnel and Materials		Fare Enforcement	Prepare System Description	Recruit and Hire Personnel																			
9.6.2	Recruit and Hire Personnel		Fare Enforcement	Budget	Train Personnel																			
9.6.3	Prepare Inspection Policy and Methods Procedures		Fare Enforcement	Establish POP Protocols	Train Personnel																			
9.6.4	Train Personnel		Fare Enforcement	Recruit/Hire; Contractor Manuals; Procedures	System Enters Service																			
9.6.5	Provide Uniforms and Gear, Facilities		Fare Enforcement	System Description; Procedures	System Enters Service																			