Report

Transit Technology Plan
Task 3: Implementation Plan

Prepared for Sarnia Transit
by IBI Group

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Executive Summary

Sarnia Transit is planning its transit technology program for the next five years as part of a broader study to develop a Transit Master Plan for the agency.

Early discussions with the agency identified inefficient data collection methods, difficulties in service management, and a dissatisfaction with the performance of existing technologies. Other concerns noted included operator safety, fare evasion, and schedule adherence difficulties related to traffic conditions. On the maintenance side, there is insufficient automation in regards to inventory and preventative maintenance, and troubleshooting for current technology is difficult and time-consuming. Lastly, the current system is not able to be expanded to meet future AODA requirement regarding external stop announcements.

An options analysis defined a large subset of available technologies in the marketplace and evaluated which technologies would be most effective at addressing Sarnia Transit's needs. Once these had been identified, cost and benefit estimates were developed in order to determine the feasibility of the modules. The options were distilled down to seven potential modules, which in turn were assessed in terms of priority:

Figure 1: Transit Technology Priorities

PRIORITY	TRANSIT TECHNOLOGIES
High	**SmartBus System (Computer Aided Dispatch / Automatic Vehicle Location) Deployment** • Tracking and management of the fleet based on GPS locations • Communication with operators via a Mobile Data Terminal • Detailed ad hoc and periodic reports to assess schedule adherence and other metrics **Rostering and Dispatch Software Implementation** • Automatic assignment of drivers to vehicles and work assignments • Integration with existing payroll and attendance systems
Medium	**Advanced Traveller Information Systems Implementation** • Enable real-time information and third party data feed • Interactive Voice Response telephone system • Variable message signs at stations • Upgraded transit information website **Automatic Passenger Counters Deployment** • Install APCs on remaining fleet **On-board Security System Upgrades** • Install a six-camera audio and video recording system on-board all vehicles **Transit Signal Priority Deployment** • Implementation of a TSP module at 10 key intersections • Equip vehicles with TSP emitters
Low	**Smart Card Fare Collection Deployment (to be re-evaluated after completion of the Automatic Passenger Counters module)** • Introduction of stored-value cards to collect fares • Integration of smart fare system with central CAD/AVL.

The high and medium priority items were structured into a 5-year deployment window according to need and technology dependencies. Overall, it is estimated that a full-scale deployment will cost a total of $1,550,000 over five years with an additional $350,000 associated with operations and maintenance of the systems during that period. The ongoing maintenance costs of the system after complete deployment are approximately $170,000 annually, including additional labour required to operate the system. These expenses (Capital and Operations/Maintenance) are outlined by type and year in the below figure for budgeting purposes.

Figure 2: 5-Year Transit Technology Program

Tasks	Capital Budget and Contingency	Annual Operations and Maintenance	Year 1				Year 2				Year 3				Year 4				Year 5			
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Short Term																						
Conventional and Demand-Responsive Services SmartBus System Deployment	$ 668,000.00	$ 98,000.00																				
Conventional and Demand-Responsive Services Rostering and Dispatch Software	$ 93,000.00	$ 19,500.00																				
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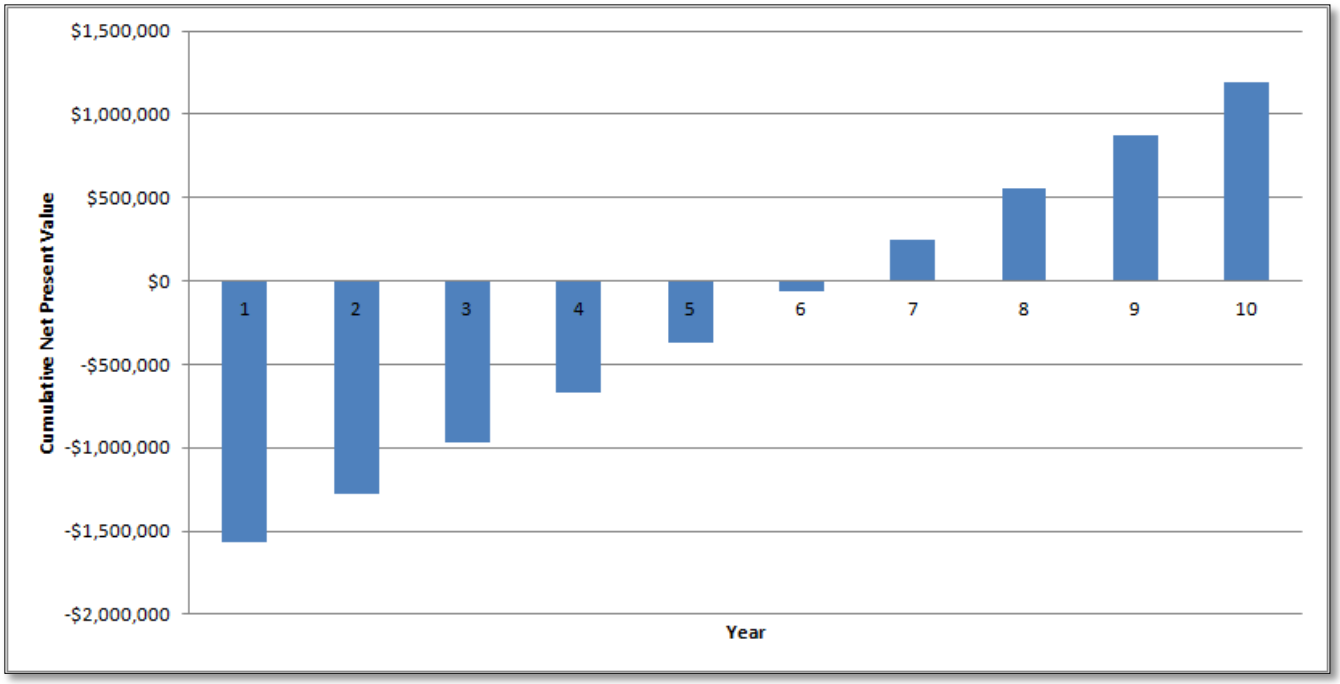
On-board Security System Upgrades	$ 192,000.00	$ 9,000.00																				
Transit Signal Priority	$ 303,000.00	$ 27,500.00																				

	Total 5-Year Expenditure	Year 1	Year 2	Year 3	Year 4	Year 5
Capital Budget	$ 1,550,000.00	$ 100,000.00	$ 480,000.00	$ 490,000.00	$ 210,000.00	$ 270,000.00
Operations and Maintenance	$ 350,000.00	$ -	$ 10,000.00	$ 70,000.00	$ 130,000.00	$ 140,000.00
Total Budget	**$ 1,900,000.00**	**$ 100,000.00**	**$ 490,000.00**	**$ 560,000.00**	**$ 340,000.00**	**$ 410,000.00**

Legend
Planning and Review
Specification and Procurement
Implementation and Testing

The above costs are off-set by a set of benefits that include: increased customer satisfaction, increased ridership, reduction in maintenance effort, reduced customer service effort, better schedule adherence, increased operations supervision, and a reduction in the effort spent on data entry. As can be seen in **Figure 3** below, the benefits of moving to this new system greatly outweigh the costs of implementation and payback is achieved during the seventh year of the project.

Figure 3: Transit Technology Program Payback



There are a number of considerations to make before undertaking a project of this magnitude. The first is that stakeholders external to Sarnia Transit may need to be involved and/or consulted on various modules, and thus need to have a strong role from the outset. In particular, City IT, Legal, and Traffic departments may have responsibilities relating to modules like upgraded security systems or transit signal priority. Further, it is important to have project leaders in order to provide in-house support, to ensure that any future system meets the needs of Sarnia Transit from a user's perspective, and to champion the adoption of the technology by staff. Lastly, there must be a focused marketing effort to encourage riders to use the new technology as it is adopted in order to receive maximum benefit from the upgrades.

Overall, the deployment of this complete system will help to improve customer satisfaction, promote efficiency in the organization, and address organizational needs that are lacking. The new system will integrate existing reporting systems and streamline reporting and management tasks. Furthermore, the program will allow Sarnia Transit to make the initial steps towards making the service AODA compliant with respect to announcements outside the buses. While this deployment is expected to take five years, the benefits will start to be realized as early as 2015 when the Rostering and Dispatch Software is in place.

2 Introduction

Sarnia Transit has retained IBI Group to develop a Transit Technology Plan ("Plan") that directly addresses Sarnia Transit's current and future transit technology needs. The Plan considers the set of technologies that provide the best overall investment, as well as improved transit efficiencies, reduced workload, and increased level of service to passengers. The Plan recommends new hardware and automated interfaces to provide additional functionality while minimizing the number of points of manual data entry. Furthermore, the Plan prioritizes the recommended projects into three implementation stages: (i) short term, (ii) medium-term, and (iii) long-term. Consideration was given to stakeholder needs, existing system sustainability, and funding availabilities in the assessment.

This Transit Technology Plan is a sub-project within a larger effort by IBI Group to develop a Transportation Master Plan for the City of Sarnia. As part of this Transportation Master Plan, a Care-A-Van review has been undertaken, and as such, this technology review is focused specifically on Fixed-Route service and Call-and-Ride. Since vehicles are occasionally required to operate as both Fixed-Route and Demand-Responsive services, there will be a number of shared recommendations.

The Plan evolved from the *Task 1: Needs Assessment* report, which summarized a series of stakeholder interviews held by IBI with key stakeholders from Sarnia Transit. These interviews identified a number of operational needs and gaps experienced by said stakeholders, and identified opportunities for improvement.

Furthermore, the Plan cascades logically from the *Task 2: Options Analysis* report, where a set of individual projects were evaluated for their feasibility. A benefit-cost analysis was performed on the individual modules first, and then on the project as a whole to determine project feasibility. Other constraints were considered to determine an ideal path that should be undertaken for any transit ITS development.

The Plan combines the two aforementioned report key findings in order to determine a fixed set of projects and develop a deployment schedule that allows maximum usability, while incorporating Sarnia Transit's funding constraints.

A summary of the sections in the report are given below:

- Section 2 – Presents a system concept that captures all of the technologies envisioned in the Plan and recommends a set of projects that are to be undertaken;
- Section 3 – Highlights implementation considerations to be accounted for during the roll-out of the Plan, in particular: external stakeholders, internal staffing, and customer acceptance considerations; and
- Section 4 – Provides a technology implementation framework for Sarnia Transit that summarizes the recommended projects identified in the Task 2 report and their corresponding level of priority, with a proposed implementation schedule for the next five years.

3 System Concept and Project Definition

This section highlights the stakeholders' technology priorities according to user and agency needs and presents an integrated system concept that addresses these needs. This concept is then linked to a set of feasible projects, as outlined in the Task 2 report, along with a proposed schedule and operating budget..

3.1 Current System

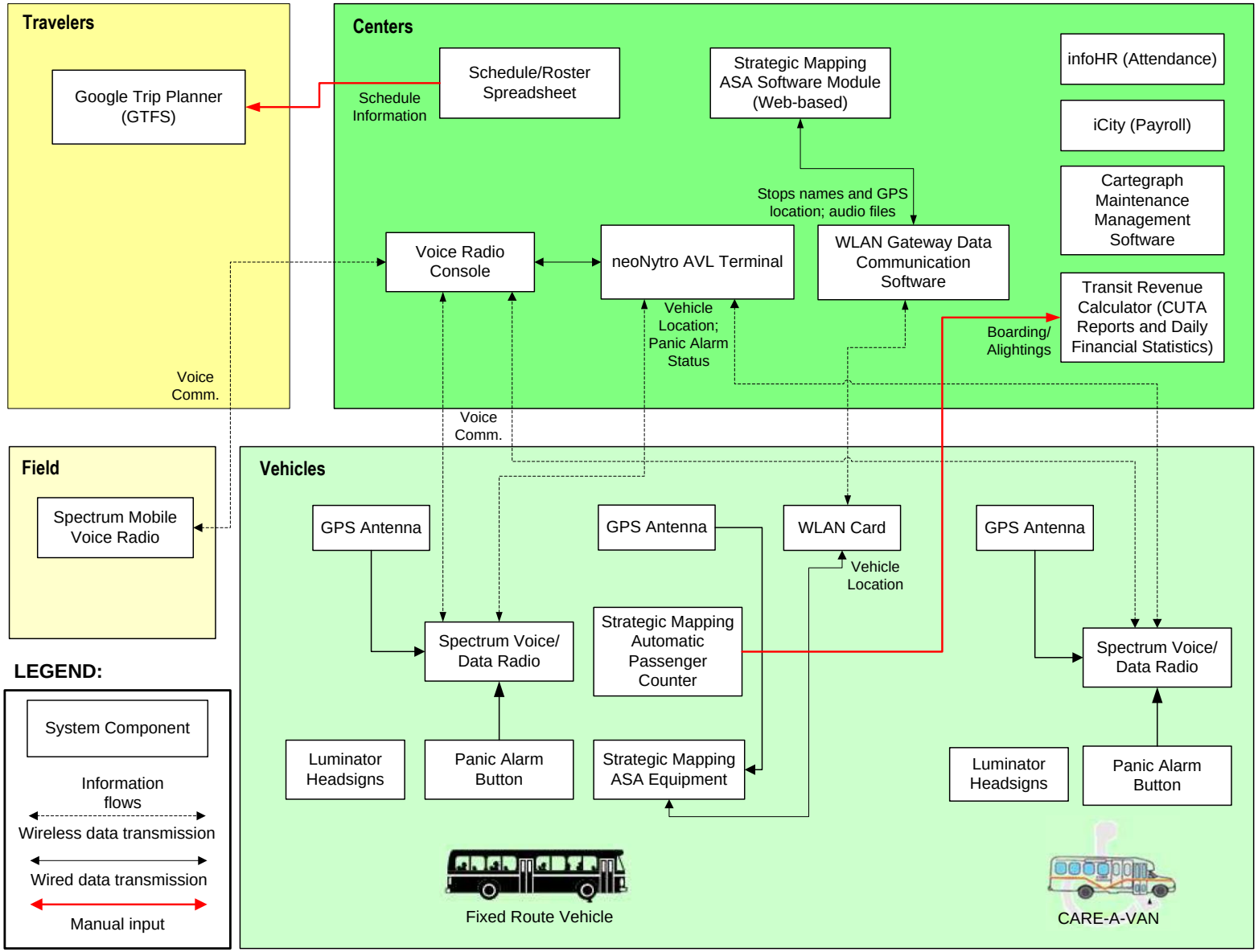
Exhibit 3-1 illustrates the system architecture for the current technology in place at Sarnia Transit. From the set of needs determined in the Task 1 report, the following were identified as of highest importance: (i) passenger-facing technologies, (ii) system integration, and (iii) automated data needs. In the current deployment, there is insufficient integration of back-end systems, limiting the extent to which the stated needs can be addressed. For example, real-time passenger data through mobile devices or through Variable Message Signs (VMS) at stations is not currently possible.

This real-time passenger data need is addressed in the proposed (new) system, as shown in **Exhibit 2-2,** introducing a more robust Computer Aided Dispatch/Automatic Vehicle Location (CAD/AVL) system capable of pushing real-time information to these systems. As an added benefit, the CAD/AVL system acts as an integrator for a majority of the on-board systems. This may allow, some existing technologies to be leveraged as part of a complete Smart Bus deployment.

The need for automated data and system integration would be satisfied through the development of customized reports that are generated automatically.

Further needs such as increased efficiency can be addressed through the transit signal priority (TSP) module, which would allow vehicles to receive extended green signals at congested intersections in order to support schedule adherence.

Exhibit 3-1: Current System Concept



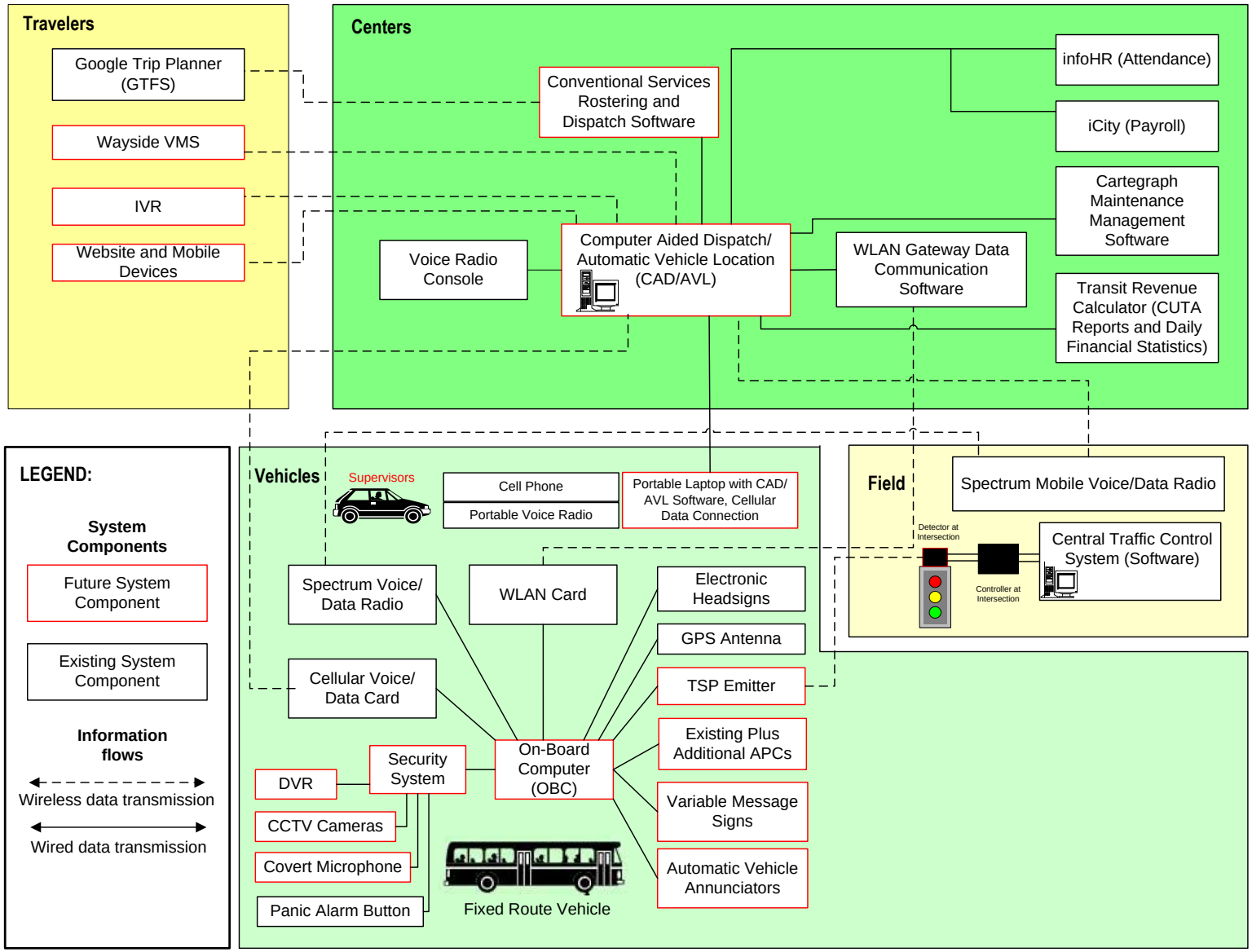
3.2 Future System Concept

Exhibit 2-2 is a system architecture diagram (also known as the system concept) for the proposed future system that illustrates how the existing and proposed technologies will fit together as part of an integrated suite of transit ITS systems. System components are categorized into four different groups: (1) Travellers, (2) Sarnia Transit Centres, (3) In-Service Vehicles, and (4) Field systems. Sarnia Transit's main centre would include a CAD/AVL dispatch workstation, as well as other software workstations and management systems (e.g. mobility scheduling).

The key system interfaces defined are:

- Interfaces between the CAD/AVL system and the City's administrative functions (e.g. payroll, attendance, transit revenue calculator);
- Interfaces between the CAD/AVL system, Vehicle Health Monitoring (VHM) system, and the current or future Maintenance Management system for tracking of fuel, parts, and work orders;
- Interfaces between on-board devices (AVL, Mobile Data Terminals [MDT], Farebox, Destination Signs, Automatic Passenger Counters [APC] Automatic Stop Announcements [ASA], etc.) and the On-Board Computer (OBC) to improve transit operation and simplify the bus operators' login procedure. With this interface, bus operators will have fewer distractions while driving; and
- Interfaces for Sarnia Transit vehicles to interact with signal controllers to receive soft priority (i.e. extended green or pre-empted red) at selected intersections.

Exhibit 3-2: Future System Concept



3.3 Recommended Projects

A series of projects have been defined,in Exhibit 3-3, representing distinct work packages that shall be pursued in order to fully achieve the proposed system concept. Within these projects, there are certain technologies requiring significant integration that are best implemented as a bundle through a single contractor to reduce both the cost and the risk to Sarnia Transit. While the Smart Bus Deployment is a pre-requisite to most other technologies, the other modules could be pursued as options on an original contract with a single vendor, rather than undertaking several procurements.

Exhibit 3-3: Recommended Project Packages and Their Descriptions

RECOMMENDED PROJECT	DESCRIPTION
1. Conventional Services Smart Bus System Deployment	• Deployment of new CAD/AVL system to the entire Sarnia Transit conventional and mobility vehicle fleet. • Central System deployment that allows the tracking of vehicle location and schedule adherence in real time. • Full compatibility with various existing and future ITS technologies. • Installation of new MDTs on all Sarnia Transit vehicles. • Provision of interfaces for communication between driver and dispatcher/in-vehicle ITS systems. • Interface the CAD/AVL to the engine control to monitor engine diagnostic messages. • Migrate the existing open-channel radio communication system architecture to a bus-to-base radio communication system architecture (requires CAD/AVL). • Integrate CAD/AVL with other onboard security systems such as camera, alert button, and video recorders. • Enable a cellular data service to facilitate data communications from the vehicle to the central system. • Provide and configure Supervisor's laptops to enable full in-vehicle access to the CAD system. • Full integration with city resources, including Maintenance Management Software (currently Cartegraph), iCity, and the Transit Revenue Calculator. • Installation of onboard annunciators (internal and external) as well as internal variable message signs in order to meet AODA requirements.
2. Conventional Services Rostering and Dispatch Software	• Implementation of a rostering/dispatch system that automatically assigns drivers to vehicles and work assignments. • Integration with existing payroll and attendance systems.

RECOMMENDED PROJECT	DESCRIPTION
3. Advanced Traveller Information Systems	• Configure central system to provide a real-time data feed to other applications and potentially third parties to enable the provision of ATIS via Interactive Voice Response(IVR), web, mobile devices, and VMS at 4 stations • Procure, install, and configure robust IVR system. • Procure, install, and configure four VMSs at major terminals; • Develop website to provide transit information via internet and mobile phone.
4. Automatic Passenger Counters	• Procure and install APCs on the remaining fleet. • Interface APCs with the in-vehicle systems for full integration with CAD/AVL.
5. On-Board Security System Upgrades	• Procure and install six-camera audio and video recording system on board all vehicles; • Integrate with DVR and existing covert alarm button.
6. Transit Signal Priority	• Implementation of a TSP module at 10 key intersections, allowing all buses equipped with a TSP emitter to receive soft priority; • Install TSP emitters on board all buses.

These project packages could be undertaken as part of a complete year-over-year initiative, or as individual separate projects. However, one key consideration is that since the CAD/AVL plays such a central role in the operation of the other systems, it will be necessary for it to be deployed first.

4 Implementation Considerations

The following sections discuss some considerations that must be made during the rollout of the system.

4.1 External Stakeholders

Some of the projects require extensive involvement from persons and departments outside of Sarnia Transit, which include:

- **TSP deployment** requires collaboration between multiple departments including City of Sarnia Planning, Engineering, Information Technology (IT), Emergency Services and Traffic departments, in addition to Sarnia Transit.
- **Integration of security systems** requires co-operation and consultation with the City of Sarnia's Emergency Services department to enable the integration; and the legal department in order to address privacy concerns.
- **Introduction of a new website and mobile application** will require collaboration with City of Sarnia's Marketing, Legal, and IT departments;
- **Integration with City-provided systems** such as iCity and Cartegraph would require support from the City Manager and IT.

Clearly, the involvement of a number of City departments during the deployment process is an important consideration when undertaking projects of this type.

4.2 Staffing

As with any technology deployment, there will likely be changes to roles of staff within Sarnia Transit, especially during and after implementation. In particular, project leaders will need to be appointed in order to champion and to take full advantage of the opportunities a technology deployment will provide during the design phase. Some of these systems require significant agency involvement to configure and deploy. Participation in these deployments must include representatives from all of Sarnia Transit stakeholder groups, such as IT, Customer Service, Maintenance, Operators, and Supervisors.

The technologies discussed in this implementation plan can be expected to impact all of Sarnia Transit's employees. Prior to deployment, staff should expect to require and receive training on all relevant systems and should be encouraged to learn and use these systems as soon as possible. Although multiple rounds of testing will occur during deployment, having an enthusiastic and engaged workforce will allow additional bugs or deficiencies to manifest themselves through regular use, and any deficiencies can be addressed early and comprehensively. All staff should be encouraged to take an interest and ownership in the technology deployment, and participate in reporting any issues found.

Overall, the success of the project is promoted by the following factors:

- Project leaders are appointed to each project;
- Strong leadership is provided;
- All relevant departments are involved through the design and implementation process, and
- That someone at Sarnia Transit is responsible for providing in-house technical support in future as required to encourage and support continued use of the system.

4.3 Customer Acceptance

Clearly, the objective of any technology deployment is to provide better service to customers, whether it be by providing additional service, additional information, faster service, or safer service. Some of these suggested technologies are very public, such as automated stop announcements and advanced traveller information. These public-facing technologies will receive significant feedback from customers, as well as foster higher ridership and passenger engagement. Some of the technologies, however, will go largely unnoticed by passengers but will provide operational efficiencies, like CAD/AVL and APCs. It is important to engage the public on the passenger-facing technologies, and to solicit their opinions. Marketing efforts should be undertaken in order to help customers accept and utilize the new services they will receive as part of the deployment.

It is also important that any major project undertaking be viewed as beneficial to all citizens of the city, not just transit passengers. Concerned citizens may have an interest in how their tax dollars are spent, and any technology deployments should be made public. Promoting the new technologies by educating the public on how to use customer-interactive technologies and designing systems with customer needs in mind will go a long way to satisfy the public. Furthermore, legal counsel should be involved at an early stage, especially where privacy concerns may manifest, e.g. security systems.

5 Implementation Plan

This section describes a proposed implementation plan to procure, install, and configure the recommended technologies defined in the Options Analysis report. A five-year horizon for the project is assumed from January 1st, 2014, meaning that all selected technologies will be considered short term or medium term. A Smart Fare System, identified in the options analysis as being not currently feasible, has been identified as a long-term consideration in **Exhibit 5-1** even though it will not be included as part of the deployment.

5.1 Recommended Project Priorities

Taking into consideration the Needs Assessment (Task 1) and Options Analysis (Task 2), **Exhibit 5-1** categorizes the recommended projects into short-, medium- and long-term priorities over a five-year timeframe. The projects recommended as part of the short-term priorities represent either higher-needs projects, or projects that are prerequisites for other projects (i.e. CAD/AVL).

Exhibit 5-1: Transit ITS Project Implementation Priority

IMPLEMENTATION PRIORITY	DESCRIPTION	PROJECTS
Short-Term	Represents immediate needs and prerequisite project deployments to be undertaken in the short term (0-2 years)	• Conventional and Call-and Ride services SmartBus System Deployment • Conventional and Call-and-Ride services Rostering and Dispatch software

Medium-Term	Represents medium priority projects and projects that require a SmartBus System Deployment as a prerequisite to be undertaken in the medium term (2-5 years)	• Automatic Passenger Counters
		• Advanced Traveller Information Systems
		  ○ Interactive Voice Response System
		  ○ Variable Message Signs at Stations
		  ○ Real Time Information via web and mobile device
		• On-Board Security System Upgrades
		• Transit Signal Priority

Long-Term	Represents projects that are not currently feasible but should be revisited in future as longer-term projects (5-10 years)	• Advanced Fare Systems (Smart-Card, etc) (To be re-evaluated for feasibility after completion of APC project)

Long-term and lower priority needs were identified in the Options Analysis report, and were seen as not feasible or desired within the next five years.

5.2 Annual Budgetary Plan and Schedule

The transit ITS project implementation schedules are divided into stages, which include the following:

1. Project Planning and Review;
2. Specification and Procurement; and
3. Implementation and Testing.

Exhibit 4-2 presents a proposed timeline for the implementation of Sarnia Transit's Transit Technology Plan based on the relative project priorities. The implementation has been structured within a time horizon of five years, beginning in January 2014. An annual budget is also shown in the exhibit incorporating capital, contingency, and operations and maintenance cost over the five-year period as calculated in the Options Analysis Report. The Plan can help assist Sarnia Transit budget the financial impact for the next five years.

In this exhibit, capital costs are calculated by assigning a weight of 4 to each implementation quarter, and a weight of 1 to each planning or design quarter. For example, if a project had a total cost of $10000, and has one quarter for each stage of the project, the costs are calculated as shown in **Exhibit 4-2**.

Exhibit 5-2: Capital Cost Calculation Example

Stage	Stage Duration (Quarters)	Weight	Total Project Weight (Sum of Weights)	Total Project Cost	Stage Cost
Planning and Review	1	1	6	10000	$ 1,667
Specification and Procurement	1	1	6	10000	$ 1,667
Implementation and Testing	1	4	6	10000	$ 6,667

Operations and maintenance costs are distributed evenly for each quarter past the projected date of completion of each project stage

Exhibit 5-3 shows the projected project schedule and associated capital and maintenance costs for the recommended implementation plan. It demonstrates that the majority of the project costs fall within years two and three of the project timeframe, and that ongoing operations and maintenance costs are projected to be approximately $170,000 per annum after all project packages have been completed.

Exhibit 5-3: Transit ITS Project Implementation Schedule and Budgetary Plan

Tasks	Capital Budget and Contingency	Annual Operations and Maintenance	Year 1				Year 2				Year 3				Year 4				Year 5			
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
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Legend	
Planning and Review	
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Implementation and Testing	