

# Advanced Transportation and Congestion Management Technologies Deployment Initiatives

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**VOLUME I –**  
TECHNICAL APPLICATION

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## Integrated Operations for Dallas Area Rapid Transit

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## a) Cover Page

Project Name	Integrated Operation for Dallas Area Rapid Transit
Eligible Entity Applying to Receive Federal Funding	Dallas Area Rapid Transit (DART)
Total Project Cost (from all sources)	\$40,000,000
ATCMTD Request	\$10,000,000
Are matching funds restricted to a specific project component? If so, which one?	Yes, \$7,500,000 for Command and Control Environment, \$20,000,000 for Customer Information Kiosk, \$2,450,000 for Video Analytics
State(s) in which the project is located	Texas
Is the project currently programmed in the: <ul style="list-style-type: none"> <li>▪ Transportation Improvement Program (TIP)</li> <li>▪ Statewide Transportation Improvement Program (STIP)</li> <li>▪ MPO Long Range Transportation Plan</li> <li>▪ State Long Range Transportation Plan</li> </ul>	TIP – no STIP - no MPO LRTP - no State LRTP - no
Technologies Proposed to Be Deployed (briefly list)	Integrated Video Management and Detection System Integration Alert Management and Response Connected Vehicle Technology Customer Information Kiosk Parking Management

## b) Project Narrative

### i. Project Description

#### 1. Introduction

The Dallas Area Rapid Transit requests ATCMTD grant funding to assist in deploying an advanced transportation management technology using and extending the technology concepts developed in USDOT's Dallas US 75 Integrated Corridor Management System to the management and operation of DART's multi-modal public transportation system. The project will also apply the technology being developed in Dallas' MOD Sandbox Project to integrate the new shared mobility provider industry into the toolkit for responding to transit incidents and service disruptions.

The US75 Corridor Integrated Corridor Management (ICM) Initiative was designed to showcase how certain technologies, agency collaboration, and collective incident response strategies can improve mobility for travelers. ICM has been sponsored by the U.S. Department of Transportation (DOT), supporting the goal of ICM to include multiple modes and multiple agencies in the highway, arterial, and transit areas. ICM is defined as the management of the corridor as a system, rather than the traditional approach of siloed management of the individual transportation facilities (e.g. freeway, arterial roadways, bus, rail, and parking).

This proposal is designed to significantly improve, leveraging modern technology and collaborative agency decision making, DART's capability to manage its growing network of multiple modes as an integrated system where success is measured by improved customer mobility rather than the traditional measures of improved operation of buses and trains. An integrated multi-modal system focused primarily on the customer has long been the

dream of transit agencies, but so far, despite investments of billions of dollars, it is DART's assessment that the dream has been elusive.

Based on the interviews with various DART departments while planning and conducting the concept of operation for this grant, several key challenges were identified to developing an advanced integrated transit control system for DART. These were very similar to the challenges experienced by the traffic engineers prior to implementing the US 75 ICM project. These challenges are listed below:

- Poor Integration of tools for decision making across transit modes and DART departments
- Redundant manual processes despite significant computerization
- Systematic underutilization of software procured to improve performance
- Lack of tools to obtain the benefit of major investments in video camera systems
- Lack of real-time performance measures for manager and executive management
- Lack of response plans for large and small non-planned events
- Failure to use real time data effectively to inform customers broadly about incidents and recommendations to customers on their options
- Inability to use the private sector providers to supplement responses to incidents
- Lack of regional transportation service providers' systems integration, coordination and cooperation, including the TxDOT Dallas district, NTTA and 13 DART member cities.

Complicating DART's ability to manage its multi-modal system is a plan for major expansion of the public transportation

infrastructure over the next six years. DART will implement a second downtown tunnel alignment for its light rail system, an expanded streetcar network, a new suburban east-west commuter rail line crossing three light rail lines and connecting to a commuter rail system connecting DFW airport with the City of Fort Worth. DART will also expand bus service significantly in 2018 and 2019, implement a new electronic pricing account based fare collection system using mobile payment technology in 2017, and smart card technology in 2018. Additionally, DART will deploy new technology to allow the integration of the new shared mobility transportation providers in 2018 to DART’s menu of transportation systems. This massive expansion facilities and services will greatly challenge DART’s ability to operate its services as a coordinated, integrated system improving the mobility of its customers unless new ICM-like approaches are implemented.

Five key technology supported investments are proposed for this grant:

- Consolidation of DART’s critical control center functions into a secure leased facility supported by updated digital SCADA (see below description) and CAD/AVL technology to manage all DART modes as a seamless multi-modal, customer focused system including the following functional areas:
  - Police Radio Dispatch (TLETS)
  - Bus Radio Dispatch
  - LRT Radio Dispatch
  - LRT Supervisor Control & Data Acquisition (SCADA)
  - Surveillance Camera Network Monitoring
  - Operations Communication Liaison Operations
  - Emergency Command Center Operations
  - Secondary Critical Functions Operations

– Regional Governmental Radio Network Operations

- Development of an enhanced a web-based, GIS oriented overlay of DART’s existing modal system to create multi-modal, multi-departmental control center management technology. This technology will include automated decision support, predictive identification of service disruption and customer impact, and selection of response plans most likely to improve transit performance, and performance measurement to evaluate success.
- Creation of a regional information exchange network among all regional transportation service providers within the DART coverage area by expansion of data sources to the fusion data engine. This will be beyond those included in the US 75 ICM project by including regional, toll road and municipal construction and incident information, expanded Regional Highway streaming video, shared mobility and taxi providers location, Scada and CAD/AVL alerts, fare equipment alerts, and improved parking management.
- Develop a library of response plans for service disruptions including detailed instructions for signage, video screen display, train operation, bus bridge plans, staffing and security plans, manpower and vehicle needs.
- Implement an integrated video server and deploy supportive analytic software to automatically select optimal camera views for incidents for use by DART Police, Customer Information, Bus and Rail Control center, supervisors and dispatch staff.
- Through a unique private sector partnership, installation of over 350 SMART kiosks and the addition of system Wi-Fi on buses, trains and at stations to be able to link DART customers into a network allowing them to “opt in” on information regarding disruptions, recommended



alternative services, and access to Shared Mobility providers during an incident. This would leverage technology being developed with the DART MOD Sandbox project.

- Develop a neural engine learning from fare equipment alerts, fare transaction information, alerts, and bus and rail location and on time performance, and passenger loads. This engine will be used to assist with response plans where shared mobility providers should provide assistance during service disruptions.
- Deploy an advanced safety system collision avoidance systems for DART's new electric bus fleet in pedestrian and bike congested downtown Dallas.

### 1.1. Technology Vision

The Integrated Operations Command System (IOCS) will be designed to optimize operational efficiency and enhance the customer experience by taking advantage of DART's workforce, assets, technology, and real estate.

The IOCS will embrace the concept of Data Intelligence that will leverage the wealth of existing DART, roadway, and commercial data that are currently accessed within separate domains. This includes an enterprise view of all available data such as audio, video, text, GIS, databases, real-time internal and external feeds, social media, and surveys.

Service Design and Delivery will be designed with a feedback loop from real-time operations to improve the understanding of travel patterns and analysis of service configurations. Operations will be improved by pre-programmed operating procedures, building on the service design, that include privacy, and data protection policies. The IOCS will present the operations personnel a view of a multimodal service with solutions integrating all modes including smart bus, big bus, light rail, TRE, paratransit, micros-transit, shared mobility providers, M Trolley, and street cars with

agencies and roadways they are traveling across.

A key part of the IOCS is the Decision Support System that aids controllers and dispatchers in choosing the right strategies, simulating outcomes, feedback on efficiency of solutions, and the transfer operating command to different subsystems. Service monitoring for DART will reflect an enterprise view by a combination of virtual and physical colocation of the command and control centers including DART police, train, bus, TVM, TRE, and paratransit, micro-transit. In addition, regional partners' control centers will be accessible through center-to-center communications within IOCS when operational plans include them in response plans.

Automation within the IOCS will take advantage of active and passive alert monitoring, system events, and automated customer communications coming from and going to various systems including field operations, fare enforcement, AVL, Public Announcement / Visual Message Board (PA/VMB), SCADA, Traffic Signal Priority (TSP), CAD/AVL, parking, mobile apps, and data portals.

Service Quality will be enhanced through IOCS automation and IOCS pre-programmed reminders to staff. Existing capabilities will be improved by expanding and enriching multimodal transportation solutions, real-time traveler information, personal travel assistant apps, integrated fare management, and real-time traffic management, and inclusion of shared mobility providers into the portfolio of incident response options. The outcome is DART providing 5 Star excellence in customer service.

The use of predictive Business intelligence will be used to anticipate disrupted transit connections, identify shared mobility or alternative transit options based upon use data from DART's Go Pass users and new accounted based fare collection system.

Business Intelligence integrated with enterprise reporting will provide key service performance indicators that can be distributed throughout DART based on departmental and enterprise goals and objectives. This information is readily available to support real-time, historical, and modeling informational needs.

Business intelligence use of regional highway and arterial speed data and predictive impacts on key express buses will inform bus operators of the optimal reroute automatically.

Communications, systems, and system networks will be integrated to support the consolidated Transit Management Center. Voice, data, video, information, and control will be provided to all departments based on the adopted protocols and standards for the sharing of information and the distribution of responsibilities. The DART Integrated Command and Control System will connect the departmental staffs on a real-time basis via communications and other technologies.

One of the key components of the advanced, multi-modal transit control system is a system which gathers data from a variety of highway, commercial, and transit sources and delivers it, through every type of user service, to multiple destinations. Information is gathered from transportation systems, emergency management systems, dispatch systems for law enforcement, and other types of systems. The System then makes this information available via a web server to DART control center users and the public as required: The main purpose of the AMTCS system is to:

- Provide an integrated platform for coordinating responses to transit incidents, transit and roadway, construction, special events;
- Provide an information exchange tool based on DART standards and best practices;
- Provide a data fusion engine to feed information to all DART control centers, marketing, customer information, and police;

- Provide a heuristic based decision support system operating in real time real-time providing information on incidents, construction, special events, transportation network status, and device status throughout the corridor; and
- Provide a response plan coordination tool for DART to coordinate actions in responding to incidents within the DART system which will recommend the best response plan based upon real time conditions;
- Provide data alerts and recommendations based upon sophisticated analytic and artificial learning tools

The goals for the new advanced technology control system include the following:

- Lower cost for managing DART's control centers by reducing manpower currently required to provide coordinated management.
- Improved communication during incidents and daily management measured to interface with management and field staff.
- Reduction in customer complaints and confusion due to service disruption
- Higher customer satisfaction due to improved communication, anticipation of incident impact, and offering of service alternatives measured to customer satisfactions surveys.
- Improved on time performance and faster travel time through automated selection and recommendation of reroutes based upon selected highway corridor data.
- Reduced data entry resulting in an increase in the use of DART's technology investments.
- Increase customer value to users of Go Pass by providing real time access to transit mobility data on buses and trains (through Wi Fi), and at platforms with the new Smart Kiosks.

## 2. Entity Entering the Agreement

DART will be the agency with overall responsibility for completion of the Advanced Transportation and Congestion Management Technologies Deployment Initiative.

The point-of-contact for our proposal is:

Todd Plesko  
Vice President, Planning and Development  
Dallas Area Rapid Transit  
1401 Pacific Ave, Dallas, TX 75226  
Phone: (214) 749-2750 / Email:  
tplesko@dart.org

### 2.1. Partners

Local, regional and private partners who assisted in the development of this application include the following agencies:

- DART Member Cities
- Denton County Transportation Authority
- Fort Worth Transportation Authority
- North Central Texas Council of Governments
- North Texas Tollway Authority
- Texas Transportation Institute
- Texas Department of Transportation
- AT&T
- Verizon Wireless
- Southern Methodist University

### 2.2. Management Approach

DART will be the primary manager of the proposed project. DART, in cooperation and coordination with its regional partners will provide all progress reporting to the USDOT, with input from the local stakeholders and consultants.

DART is committed to manage this project to meet the scope, schedule, and budget. DART

is well versed in Project Management methodologies and Systems Engineering methodologies.

We will utilize Project Management Institute (PMI) standards in the development of our Project Management Plan.

The project management plan will describe how the project management system will be used and states how the work will be performed. As with any project, the management of it will consider the triple constraint of project scope, budget, and schedule.

## 3. Geographic Area

The geographic area is defined by DART's service area. The 700-square-mile service area includes the City of Dallas, Texas, and 12 surrounding cities: Addison, Carrollton, Cockrell Hill, Farmers Branch, Garland, Glenn Heights, Highland Park, Irving, Plano, Richardson, Rowlett, and University Park. Located in the heart of North Texas, the Dallas area has experienced tremendous growth over the last 5 years with a number of fortune 500 companies, such as AT&T, Texas Instruments, Southwest Airlines, and Toyota calling it home. The area is expected to continue this upward trend with an estimated population of nearly 9 million residents by 2027.

The area provides residents with options to travel to places of arts and culture, to sports, recreation, dining, and special events.

### 3.1. System Overview

We begin with the transportation modes applicable to this project. **Error! Reference source not found.** lists commonly encountered modes in surface transportation and the facilities on which they typically operate. These are the modes applicable to this project.

**Table 1: A Taxonomy of Transportation Modes and Facilities**

Mode	Facility
Light Rail Operations	Rail Operations Center/ Light Rail Station
Street Car	Rail Operation Center/Streetcar Stops
Bus Operations	Bus Operations Center/Transfer Station/ Bus Stop
Commuter Rail	Commuter Rail Operations Center/Rail Station
Para-Transit / On-Demand	Paratransit Operations Center

**3.1.1. Transit Network – Light Rail**

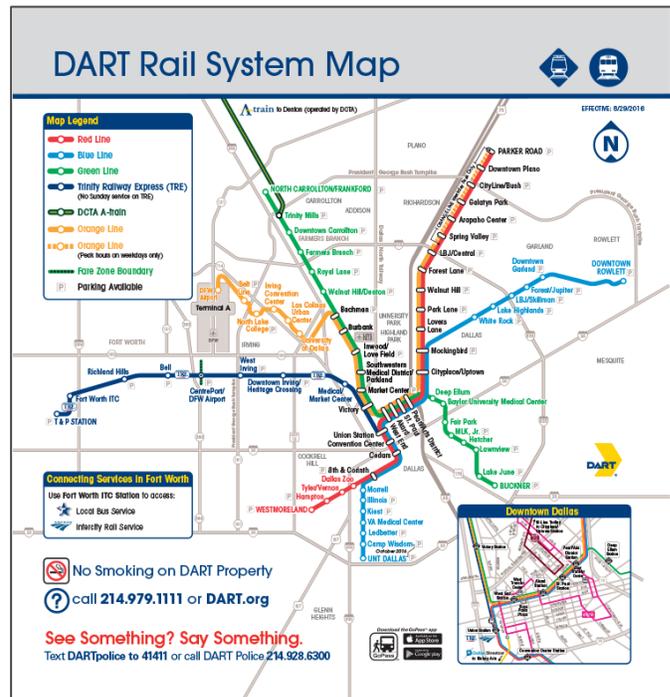
Currently, DART operates 92.5 miles of LRT service. All light rail lines operate at 15-minute peak period and 20-minute midday and evening period frequencies on weekdays. There are 64 stations – 52 at-grade, 9 aerial, 2 below-grade, 1 tunnel. There are 2 light rail maintenance and operations facilities.

By 2024 DART will add an additional downtown tunnel, three additional below grade stations, and one additional at-grade station.

**3.1.2. Transit Network - Bus**

DART operates an extensive bus network in the service area with a fleet of 660 vehicles providing an average weekday ridership of 126,229 passenger trips. There are 27 local routes, which serve downtown Dallas. Some locals link the suburbs with downtown Dallas. There are 9 express routes which ferry passengers between two areas with limited or no stops in between. These utilize High Occupancy Vehicle (HOV) lanes on freeways when possible. There are 15 suburban routes, which link the suburban neighborhoods of DART to transit centers. DART has 20 crosstown routes which run through Dallas and its suburbs, but not downtown. The final fixed route category are the 50 rail-feeder routes that start and/or end at rail stations.

Most trips in the DART system are carried by the bus system. DART numbers its bus routes per the type of route:



**Figure 1 - DART System Map**

- Local routes, serving downtown: 1-183 (routes numbered in the 100's operate via freeways for a portion of the route approaching Downtown Dallas)
- Express routes, limited-stop service using larger vehicles with reclining seats: 200s
- "Suburban" routes, local routes originating at a transit center: 300s
- Crosstown routes, local routes connecting widely separated areas: 400s
- Rail feeder routes, local routes originating at a rail station: 500s

In addition to the above regular fixed routes, DART will also contract with its neighbors or businesses and run circulator routes, like the Southern Methodist University or North Park Center circulators or shuttles for Texas Instruments or UT Southwestern Medical Center. The circulator routes are given number in the 700 range, while the shuttles are listed in the 800s.

DART runs its bus system primarily as a hub and spoke model. DART has several bus-only facilities, which include transit centers, transfer centers, transfer locations, and Park & Rides. There are 3 bus maintenance facilities. DART has 7 transit centers and two Park and Ride locations.

### 3.1.3. Transit Network – Commuter Rail

In addition, to make transfers easier, most rail stations act as hubs for DART buses.

DART partners with the Fort Worth Transportation Authority (the T) in the operation of the Trinity Railway Express (TRE), a 34-mile commuter rail line connecting downtown Dallas and the DART service area to Fort Worth. The TRE, was created in 1996 by an inter-local agreement between DART and the Fort Worth Transit Authority.

The TRE commuter line has an average weekday ridership of 7,300 passengers per day and is the fifteenth most-ridden commuter rail system in the country.

There are 10 TRE stations (5 in DART Service Area) and 1 maintenance and operations facility.

By 2022 DART will add 26 more miles of commuter rail service between Plano and DFW Airport and up to 11 additional stations.

### 3.1.4. Transit Operations – On-demand and paratransit

DART provides on-call neighborhood service in eight areas, each anchored at a bus or rail station and curb-to-curb paratransit service to

customers with disabilities that are unable to ride DART buses and trains.

Prior to the bus and rail changes on October 6, 2003, DART launched its premium on-call shuttle service to replace many low-productive DART bus routes. It was first opened in some North Dallas and Plano neighborhoods and, in late 2005, it expanded to Glenn Heights in Northern Ellis County. DART On-Call currently operates on weekdays only (except on holidays.)

The On-Call service currently serves north central Plano, eastern Rowlett, Farmers Branch, North Dallas, Lakewood, Richardson, Lake Highlands, and Glenn Heights.

DART introduced a new service into its system called a "Flex" service in 2008. It is like DART On-Call but combines the advantages of a fixed bus route along with curbside pickup. It uses a local fare on stops at fixed routes and/or a premium fare on curbside pickups and drop-offs within the Flex zone if time permits. Customers in those areas who desire a pickup at a specific location may do so by calling DART 1 hour before their destination time or at stop.

The Flex service currently serves the following areas:

- East Plano (replaced routes 570, 760, and DART On-Call East Plano.)
- Garland/Rowlett (replaced route 557.)
- Pleasant Grove (replaced route 342.)
- South Irving (Clockwise/Counter-clockwise. Replaced portions of routes 302 & 306)
- South Plano (to replace busiest portions of Telecom Corridor Flex Service during peak hours)
- Telecom Corridor (Bi-directional, weekday rush hours only) (replaced portions of route 316)

DART is expanding its on demand services through a FTA Mobility on Demand Sandbox grant where shared mobility providers will be integrated into DART's strategy for first-last



mile access. A pilot test of this project will be deployed in Plano and parts of Southern Dallas.

## 4. Real-World Issues and Challenges

This section summarizes the problems, issues and needs of the current systems and processes within DART. It also addresses operational,

technical, and, institutional deficiencies and constraints, as such; it provides insight into the types of problems being faced by DART related to providing an integrated operation for transit services to its customers.

Based on the interviews with the various departments, the identified key challenges are listed below:

**Table 2: Challenges**

Challenge	Description
<b>Lack of Integration</b>	From an operational point of view, departmental systems are not integrated for logging and communicating events such as the Trapeze, VBS, SCADA, and PAVMS systems. Communication between groups is done primarily through phone calls when other departments are needed. There is no data sharing among systems, which potentially could cause issues and reduce the efficiency of responses to events and reduces the utilization of the software investments that DART has already made.
<b>Manual Processes</b>	Many of the coordination activities, such as field support, bus bridges, vehicle repairs, and detours, are done through manual processes, as mentioned previously the phone is used to coordinate activities. The responses to incidents are not pre-planned, so the experience of the train controllers, bus dispatchers, and the supervisors is relied upon to setup bus bridges, response to equipment breakdowns, etc.
<b>Low utilization of existing functionality</b>	Both the Bus Management System (Trapeze) and Light Rail Management System (INIT) have the functionality to provide additional data integration between systems, and provide much of the systems integration needed for an integrated command and control system. However, these software systems have been procured and implemented as separate projects lacking an enterprise system design. The resulting underutilization, by not taking advantage of the available features and capabilities, should be explored. These systems may have existing modules, but not purchased by DART, for enterprise integration.
<b>Lack of video sharing</b>	Currently, DART has CCTV cameras installed on buses, and on rail platforms and transit centers. However, the DART Police operates and maintains the video management system, and the live feeds for the platforms and centers are not available in the operations rooms. The bus cameras are available through a website; which bus operations logs into to view the cameras on the buses when alarms are generated by the bus driver or by the bus (such as erratic movements.) Access to the live CCTV is restricted by DART police due to server limitations and access to the video management system.

<p><b>Lack of real-time performance measures</b></p>	<p>As part of the operations, current performance of the system is not measured on a real-time basis. By providing real-time performance measures, the operational managers of the DART systems could understand where focus is needed to improve the service to their customers, both internally and externally.</p>
<p><b>Poor non-planned event communication</b></p>	<p>Pre-planned events within the area are well communicated and DART services are well coordinated during these events. However, un-planned events can be a challenge for communicating internally and to the public. For instance, several stories were relayed about bus bridges and the challenges of communication during bus bridges. Sometimes the Bus Drivers do not know their route during the bus bridge, and have provided incomplete or inaccurate information to the public. Several employees mentioned that they personally had experienced this, and would usually ask the bus driver to call dispatch for clarification. The public needs some notification and clarification when things are not operating as expected.</p>

## 5. Transportation Systems and Services

The fast-growing population and rapidly evolving urban layout poses some unique challenges for DART as an agency, as well as for the regional stakeholders. Urban mobility is one of the toughest challenges the regional stakeholders will face in the coming year. DART has set key goals to improve mobility in the Dallas area to bring together various jurisdictions in the Region, modal interests, and service providers to focus on the common goal of optimizing the performance of the entire surface transportation system by covering the proposed services:

- Consolidate DART System Information: Transit is becoming a more attractive option for many commuters in the region. DART serves 13 Cities through a network of 700 square miles with more than 220,000 passengers a day. DART has set a roadmap to upgrade key systems, integrate the various DART Enterprise systems, and supplement the gaps with private sector partnerships.

Expand the existing ICM coverage included in the US 75 ICM project by including regional,

toll road and municipal construction and incident information, expanded regional highway streaming video, shared mobility and taxi provider locations, SCADA and CAD/AVL alerts, fare equipment alerts, and improved parking management.

Develop a library of response plans for service disruptions including detailed instructions for signage, video screen display, train operation, bus bridge plans, staffing and security plans, manpower and vehicle needs.

Develop or upgrade the IEN system as an enhanced GIS oriented overlay of DART’s existing modal system to create multi-modal, multi-departmental control center management platform. This technology will include automated decision support, predictive identification of service disruption and customer impact, and selection of response plans most likely to improve transit performance, and use performance measurement to evaluate plan success.

Enhance fusion, archiving, sharing and performance measures – The building blocks of any multi-agency, multi-modal integrated system is its data collection, fusion, dissemination, and archiving applications. With the USDOT’s recent ruling on the need to

develop performance measures reports, the need to automate the entire process is essential.

Implement an integrated video server and deploy supportive analytic software to automatically select optimal camera views for incidents for use by DART Police, Customer Information, Bus and Rail Control center, supervisors and dispatch staff. The video sharing will also include video streams from the regional partners.

Deploy 350 SMART kiosks and addition of system Wi-Fi on buses, trains and at stations to link DART customers into a network allowing them to “opt in” on information regarding disruptions, recommended alternative services, and access to Shared Mobility providers during an incident. This would leverage technology being developed with the DART MOD Sandbox project.

Deploy an advanced safety system collision avoidance systems for DART’s new electronic

bus fleet in pedestrian and bike congested downtown Dallas.

The connected vehicle application will entail modifying the Trapeze application to interface with the EcoTrafIX™ software to obtain real-time data and provide this information to the vehicle for dissemination to include real-time information relevant to the bus trip.

### 5.1. Integrated Regional Mobility Information

Operational efficiency cannot be improved if the situation of awareness is not expanded to facilities outside the agencies’ areas of responsibility. The integration of the regional mobility information is a key stepping stone to achieve the goals set forth by DART and the regional stakeholders. The Data Hub represents a pattern shift from silos of information and applications to a shared data environment that synergizes data streams and data sources not previously integrated to support data analytics of value not previously captured.

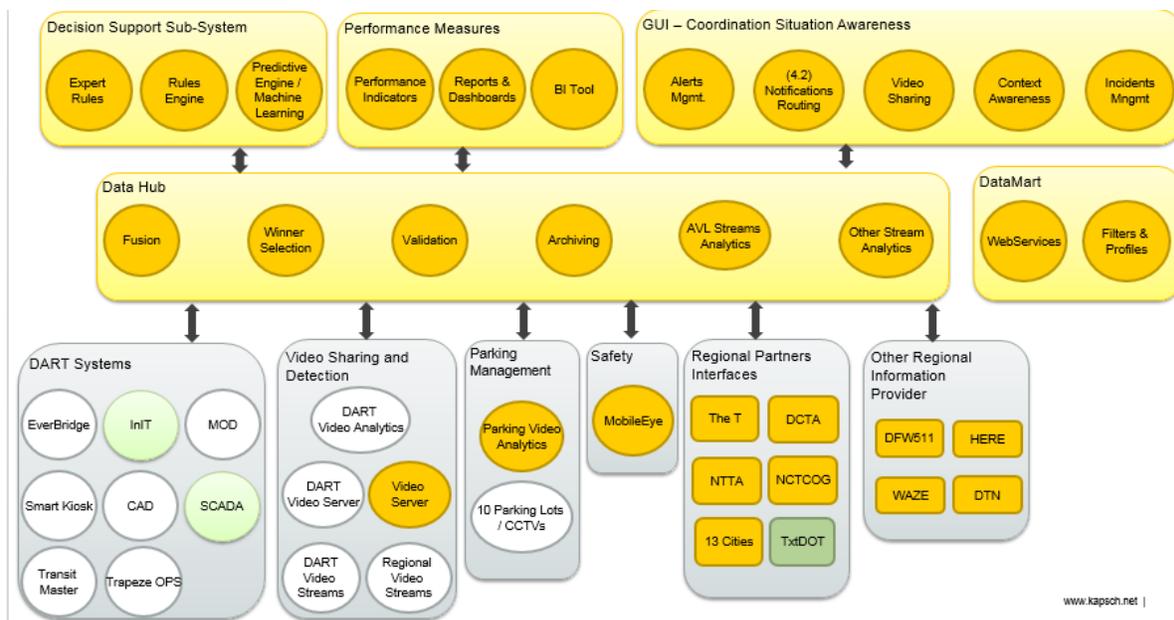


Figure 2: ATCMTD Conceptual Architecture

#### 5.1.1. Seamless Integration of DART’s Enterprise systems

The data integration of the key DART systems will be done through various Data Connectors

pulling together necessary information into the ATCMTD Data Hub, including but not limited to:

- Operations Control Log (OCC) is an Access database for train incident reporting.
- TransitMaster Incident Reports is used for bus incident reporting.
- Publisher is an application which is used to provide social networking notifications
- Everbridge is a system used to send out internal notifications to DART staff members.
- PA/CIS is used to send communications to VMS at train platforms and stations.
- GoPass is a mobile app provided by DART in partnership with the T, TRE, and DCTA.
- TRAPEZE – Provides driver assignment for Bus and Light Rail Vehicles (LRV)
- GE SCADA – Provides Rail Signal, Electrification, Tunnel Ventilation information
- VBS INIT – Provides LRV Tracking and Management, Street Car Tracking and Management
- IBM Cognos Business Intelligence – is used for reporting, analytics, financial analysis
- DriveCam/ SmartDrive – Provides driver performance information
- HERZOG – Provides commuter rail information
- SPEAR – Is a Maintenance Asset Management System
- Dallas MOD: Under this project, DART combined traveler applications to create an integrated, multimodal application that leverages ride-sharing services. The project will improve ease of access to DART stations, particularly in non-walkable areas not well served by transit. This project will provide a direct link to collect real-time information from traveler side.

### 5.1.2. Integration of On-Going Key Regional Projects

This project will leverage on existing regional investments to include all of the regional data elements that will be collected, fused, and provided by the ATCMTD Data Hub:

- **Dallas ICM Demonstration**  
 The Dallas ICM project aggregates some key regional information such as incident, construction, special event, transit, parking, and traffic flow and weather data into the ICM data hub. This project data coverage was expanded outside the Dallas ICM corridors.
- **511DFW**  
 The 511DFW system serves as the single source for real-time, comprehensive regional traveler information that includes planned and unplanned incident information and status; modal availability; travel times; speeds, conditions, and congestion information for roadways; transit routes, schedules and vehicle tracking; weather; and parking management.

### 5.1.3. Regional Data Interfaces and Data Integration

The data interfaces that will be developed and deployed for the ATCMTD implementation, will be used to collect data, fuse the data, and store the data in the data warehouse for use by the other systems include:

- **Traffic Signal Data** – Traffic Signal Status, Location, and Timing Plan data from the Cities’ systems
- **GTFS Data** - Transit Schedule and Route Data will be collected from the GTFS data feed
- **Transit AVL/APC Data** – The real-time location and occupancy of transit vehicles will be collected from the DART real-time transit systems.
- **Weather Data** – Weather forecast and radar information will be integrated from the DTN weather services
- **ATMS Data** – ITS device (DMS, CCTV), speed, volume, occupancy, and event data will be received from the TxDOT C2C interface and the Cities’ systems

- **V2X Data** – Connected Vehicle information will be received from the Trapeze RSUs deployed within the region
- **Parking Management Data** – Parking Data will be reviewed for 3 park and ride lots.
- **3<sup>rd</sup> Party Data** – Traffic information will be integrated from three different providers: HERE, MOD and Unwire.

## 5.2. Improve Operational and Mobility Efficiency

### 5.2.1. Consolidated Transit Management Center

The daily operation of DART services will be coordinated through a combination of systems integration, new features, and the introduction of an enterprise data fusion platform to link current operational platforms. The central point of coordination for DART operations will be a consolidated Transit Management Center where all of the operational modes will be co-located to coordinate operations within the region.

### 5.2.2. Multi-modal Information Exchange Network (IEN)

EcoTrafIX™, Kapsch's Advanced Traffic Management Solution currently used as an IEN under the Dallas ICM project and DFW511 will be expanded to manage the DART's transportation networks and maintain situation awareness in the project region for all stakeholders.

### 5.2.2.1. Map Centric Solution

EcoTrafIX features a highly map-centric, browser-based interface. The EcoTrafIX platform provides a powerful, user-customizable map that allows for accurate geographic display of all DART and ITS assets that will be included in this project deployment. The EcoTrafIX GUI provides a map-centric way of working and collaborating that is recommended by human factors experts. The ease of use increases efficiency while minimizing distractions.

### 5.2.2.2. Event Management Module

The EcoTrafIX event management module allows regional operators to create incidents or planned events and associate all details required, from impact to stakeholder contact information, and can also identify if another event is conflicting in the vicinity of the planned event. Events can automatically be associated with an action plan or can be manually associated to a plan that is suitable. The feature set implemented for the Dallas ICM implementation works well as it has been deployed, but needs to be expanded to meet DART's operational needs. Under a Concept of Operations Study, DART has designed a new transit event entry screen mockup for use within the EcoTrafIX product that will help transit operators to quickly and efficiently enter and manage transit related events within the IEN. The mockup is shown in the figure below.



**Figure 3: Integrated Transit Incident Entry Mockup**

**5.2.2.3. Situational Awareness for Informed Decisions**

Traffic conditions are monitored continually, feeding dynamic map displays and level of service algorithms to detect anomalies. Field devices, DART assets, and equipment will continuously be monitored for status and real-time data. EcoTrafiX is designed to capture, aggregate, and archive all data, status and alarms, as well as to help operators and managers view, analyze and maintain situation awareness in a common operational view.

**5.2.2.4. Alert Management**

The Alert Management component will identify, rank and prioritize system alerts for all command, control and communication systems to provide DART, regional partners, and the public with predefined, real-time automated alerts. The ATCMTD Data Hub will capture alerts generated by individual command control systems such as DART SCADA (elevator/escalator, grade crossing gates, tunnel ventilation/intrusion, etc.), Ticket Vending Machines (fare media, fare collection, financial transactions, intrusion, faults, etc.), Train Movement - VBS (delays, occupancy, diagnostic log, etc.), Employee/Vehicle Bus Assignment, Trapeze (vehicle assignment,

employee work plan, pay, login, etc.) Bus Movement - Transit Master (delays, occupancy, diagnostics log, etc.), Weather (movement, forecast, intensity, etc.), Accidents/Constructions (incident details, impact, location, etc.), highway traffic (speeds, congestion, alternate routes, etc.) and disseminate the alerts based on predefined triggers and filters. The alert engine will be very tightly connected to the machine learning predictive engine described in the sections below.

**5.2.3. Expand on the Decision Support System (DSS)**

The DSS is an essential system for the operating agencies to implement coordinated strategies to meet transportation performance measures and respond to recurring congestion and planned and unplanned traffic events causing congestion and/or delay. The DSS will become the collective knowledge resource to select appropriate response plans either through an automated or human process and determine potential corridor benefits of proposed response plans. The Decision Support efforts start with a need to collect comprehensive and reliable information about how individual elements are operating. All collected data must further be

validated prior to being used to ensure that no erroneous information is used in system evaluations. Data processing may also involve the application of data fusion algorithms designed to address potential discrepancies

among data collected from various sources and gaps in collected data. The Decision Support System will analyze, evaluate and trigger action plans.

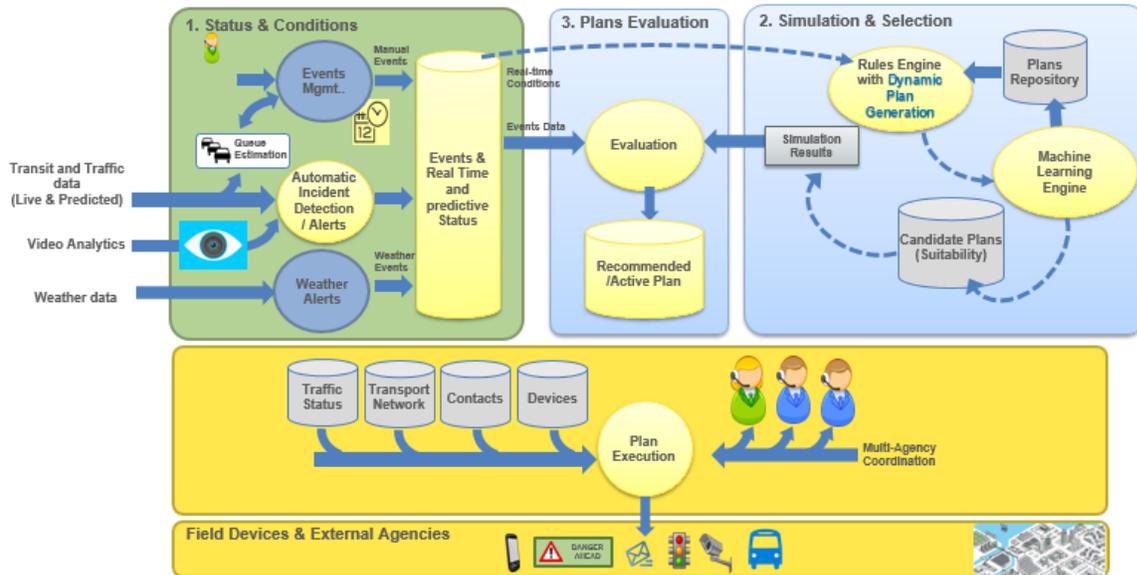


Figure 4: DSS Flow

**5.2.3.1. Expert Rules Engine/Evaluations**

The Expert Rules Engine will carefully monitor the Data Hub data to evaluate the network and to manage given conditions within the DART transportation network and the region networks. At every evaluation cycle, available management strategies would be assessed by the rules engine to determine their effectiveness in addressing the identified operational problems. Only the strategies that can physically be implemented would be evaluated. The system evaluations would be done by drawing strategies from rules or playbooks describing potential supply-side and demand management solutions. The DSS rules engine would be designed to operate in a real-time environment using the current conditions for plan evaluation and possibly on predictive conditions based on the output of the predictive machine learning engine. It would use various processes and analytics to evaluate current system operations, determine the near-term impacts of individual strategies or groups of

strategies, and provide recommendations on which strategies to implement.

**5.2.3.1. Predictive Engine – Machine Learning Pilot**

The proposed predictive engine approach is distinctive as it uses a Predictive Machine Learning (PML) method. As the name suggests, it implies that the predictive engine will learn over time from the data collected in the Data Hub to predict conditions and trigger the evaluation engine to select one or multiple DSS Plans. The iterative aspect of machine learning is important, because as the model is exposed to new data, it will independently adapt and project conditions. The model will learn from previous computations to produce reliable, repeatable decisions and results. This module will be considered a pilot and will be evaluated using the systems performance measures as a loop back to calibrate and make the required adjustments. The use of the machine learning

will be applied to the various data elements and evaluated continuously.

### 5.2.3.2. Response Plan Playbook

The response playbook will be a combination of supply strategies elements and demand strategies elements that will be used to build the response plans and unified response to specific conditions affecting the network(s). For each incident or alert scenario, a response plan set will be developed which will utilize a combination of the following response plan elements below:

- Existing detour routes defined by DART and Regional Stakeholders
- Group of coordinated signal timing plans for a set of signalized intersections along the detour routes.
- DMS signs and messages to be used
- TMC Operator standard operating procedures
- Stakeholder Notification
- Bus Routes impacted by the response plan
- Route Enhancement: recommend changes to the schedules based on delays, earlies, ridership, and connections, if the ridership is heavy, recommendations will include increasing frequency, adding more vehicles, and additional strategies. If connections are being lost, alerts will be sent to the planners for route adjustments.
- Connection Protection: Alert Trapeze-VBS integrated environment with connection alerts and rule based directives. For example, in the event of a delay in the arrival of a last train, the DSS will monitor current conditions and will automate the sending of alerts to notify the last bus to hold for the train.
- Traveler Mobility Elements:
  - Park and Ride recommendations
  - Bus Bridge availability
  - Transit Recommendations

### 5.2.4. Systems and Operations Performance Measures

Performance Measures obtained via analytics and dashboards can be used to provide important statistics that can help to detect and correct issues found within a transportation network. The Performance Measures system will provide analytics and graphical dashboards that will allow the regional stakeholders to view archived, statistical data related to the regional transportation network. The dashboards will contain support for multiple profiles corresponding to the multiple views and roles in the system ranging from seeing high-level status, to corridor level performance, to very detailed status of intersection data.

#### 5.2.4.1. Real-time Operational Dashboards

The first level of dashboards are the operational dashboards that show current conditions within the transportation network boundaries, potential incident locations, and status of the equipment. By providing real-time performance measures, the operational managers of the DART systems and the regional partners could understand where focus is needed to improve the service to their customers, both internally and externally.

#### 5.2.4.2. Supervisory/Executive Dashboards

Supervisory dashboards provide the operation's supervisors with indicators of situations outside of historical norms. This may include levels of congestion, or volumes on certain roads, for example. Executive dashboards are provided to agency leads and policy makers to show the high-level conditions of the transportation network in the region. As an example, an Executive Dashboard may include the following:

- Where is my Train?
- Has the accident been cleared?
- What is the load on the train?
- What's going on at the platform?
- How is the weather?
- How heavy is traffic?

## 5.2.5. Integrated Video Management and Video Sharing

### 5.2.5.1. Video Management and Sharing

The current DART Video Management System has some limitations due to software, policies, and network bandwidth. Agreements with TxDOT, NTTA and City of Dallas to share video feeds need to be negotiated as part of the ICCS process. Organizational processes related to video access for more than just security concerns need to be documented and approved. Older video systems will need to be replaced at end-of-life with pan-tilt-zoom cameras or 360 degree cameras. An enterprise system design will need to be part of the ICCS design process to integrate disparate video systems purchased in stand-alone projects. Camera feeds throughout DART will be used for both security and operations with distribution mechanisms put in place so that video is available within the Consolidated Transit Management Center. Video will be displayed on Video Walls within the transit operations center(s), and integrated so that controllers and dispatchers can view specific videos feeds from their console.

### 5.2.6. Rapid Deployment Camera System

DART has deployed a pilot project for rapid deployment camera (RDC) technology to demonstrate how RDCs can be utilized during Emergency Operations Center (EOC) Activations at the Annual State Fair of Texas EOC Events. RDCs with Video Analytics can be utilized to effectively monitor Terminal Operations or for regional special events.

### 5.2.7. Expand on DART Video Analytic System

DART's VSOM system provides video analytics capabilities that can be deployed to automate the monitoring process with auto alerts based on set triggers. This may apply to incident detection, service disruption, trains displaying similar destination signs, stopped

buses or any operation conditions requiring the triggering of an alert.

## 5.3. Improve Traveler Information

### 5.3.1. Smart Kiosk

DART is looking to establish kiosk stations at key locations to serve as interaction points with their customers. Some of the features identified for integration into the kiosks are:

- Wayfinding: Provide travel/Transit information as it relates to DART services
- Emergency notifications: Sharing emergency service disruptions or information from riders
- Cellphone charging stations
- Wi-fi access
- Advertising channels
- GoPass Tap card validation and account information
- Traveler information to commuters.

The kiosks will be installed in 64 light rail stations, 9 transit centers, 10 commuter rail stations and other locations identified by DART. The number of requested placements will potentially range from 350 to 500 kiosks.

### 5.3.2. Data Mart Web Services

The Data Mart Web Services are an integral part of the ATCMTD, allowing for easy dissemination of collected and fused data to DART Mobility on Demand and GoPass projects, the 511DFW system, regional partner agencies and news and media outlets. The fused data could also be made available to project partners and third-party application developers through the integrated Data Mart. Information will be published to various data consumers via numerous transportation methods, most notably XML web services. The high impact, real-time transit, traffic, transportation, weather and ITS device static and dynamic information will be shared with various data consumers, including the Public, Private Agencies and Social Media outlets and third-party application developers.

The Data Mart Web Services will serve as a key dissemination mechanism responsible for providing the sharing of data among DART and its partner agencies, thereby helping to improve data sharing in the region.

#### 5.4. Improve Safety on Transit Vehicles

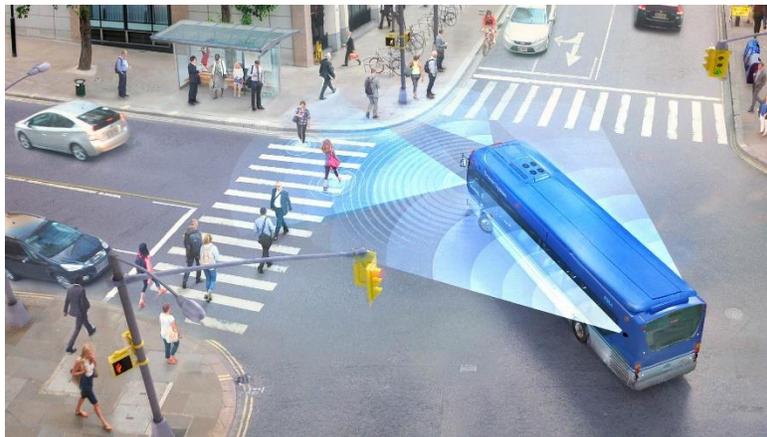
Transit vehicle drivers face a tall task: safely operate long buses, overcome limited visibility, and navigate crowded city streets and crosswalks. With all the distractions of an urban environment, it can be easy for a bus driver to miss a pedestrian or cyclist in their blind spot. The U.S. National Transit Database reported that transit vehicles were responsible for over 65,000 injuries over a 5-year period.

To address this issue, DART is proposing to install the Mobileye Shield+ subsystem on their

seven (7) electric busses, which will be put into operations by the end of 2017. The purpose of the Mobileye Shield+ system as part of this project is to provide transit vehicle drivers with an audible and visual safety tool that avoids incidents between equipped vehicles and pedestrians / bicycles.

The Mobileye Shield+ subsystem uses four (4) camera-based multi-vision smart sensors, which are strategically placed around the bus: in the front, on the left, and right sides. Shield+ leverages dynamic detection angles to constantly monitor the driving environment. The subsystem identifies:

- Vehicles
- Pedestrians
- Bicycles



**Figure 5: Mobileye Shield+ Subsystem (Source: Mobileye)**

Additionally, the subsystem can identify Lane Markings and Speed Limit signs to provide additional safety benefits to the transit vehicle.

The system continuously scans the sensor areas for ‘obstacles’ (pedestrians and bicycles) measuring over and over again and tracking pedestrians and bicycles, it detects in the cones of visions of the 4 detectors. If the system determines that there is a potential danger in the path of the vehicle (regardless if it is a left turn, right turn, or a straight movement), it will provide the driver with visual and audible

warnings that are displayed on mobile devices (smart phones or tablets).

The Mobileye Shield+ subsystem has been designed and tested to minimize false alerts ensuring that the drivers will only be exposed to real alerts overcoming the credibility issue often associated with new technologies.

Additionally, the subsystem is provided with a fleet management system that aggregates the data from the sensors including any warnings and alerts issued to allow DART to identify

vehicle/pedestrian and vehicle/bicycle incident hot spots.

### 5.5. Connected Vehicle Pilot

The emerging connected vehicle (CV) technology and associated solutions offer many advantages, one of which is offering an alternative method to provide traveler information to vehicles. Currently, a decision support system (DSS) will use dynamic message signs (DMS) and 511 systems as in-route forums of traveler information. However, CV technology offers another method to provide information directly into vehicles that have CV-compatible equipment and software installed.

In most current CV deployments (test beds, Safety Pilot, CV Pilot projects), stationary roadside units (RSUs) are used to convey traveler information from a central system to equipped, passing vehicles. However, the average range of the RSUs is 1000 feet, which

limits the transmission of CV data from RSUs to in-vehicle units to the coverage range of the RSUs.

Another communications technology, Wi-Fi, is already deployed in DART transit vehicles providing a convenient communications path from the back-office system into the vehicles. This Wi-Fi-based system was developed and deployed by Trapeze Group using their Transit Master software. As part of this project, Trapeze will modify their software to interface with the EcoTrafIX™ software to obtain real-time data and provide this information into the vehicle for dissemination.

The traveler information data that will be provided is:

- Incident information
- Event information
- Weather-related warning information
- Work Zone locations

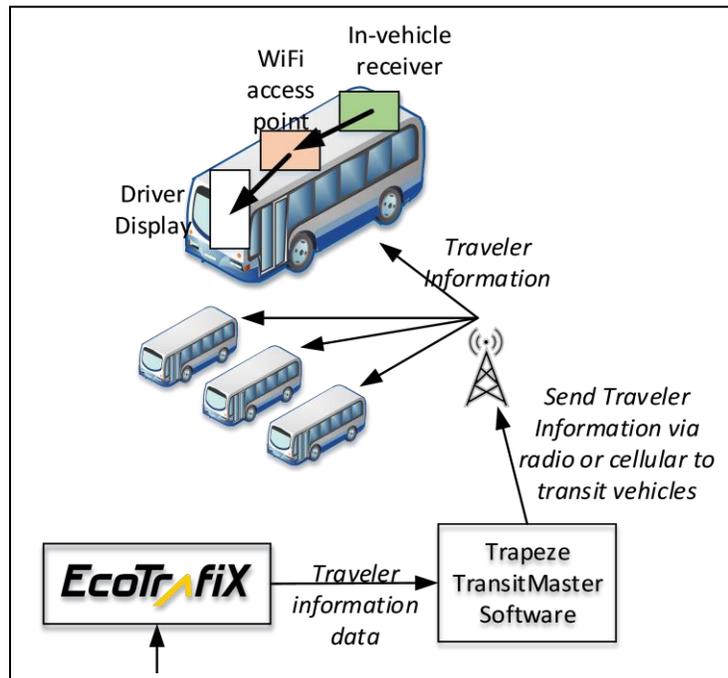


Figure 6: Wi-fi based CV Subsystem for Travel Information

The high-level architecture of the proposed Wi-Fi-based CV subsystem consists of the components shown in Figure 6.

For the purpose of the project, the deployment of the Wi-Fi-based CV subsystem will include the provision of the modified Trapeze TransitMaster software, an interface with the traveler information-providing EcoTrafIX™ software, and updated software and hardware (driver display) to present traveler information. EcoTrafIX™ will obtain the traveler information data from connected data sources and from the DSS. The proposed modifications will be maintained not only during the project’s maintenance and operations phase, but is a vital technology approach for DART’s overall operations. DART and its

stakeholder will also benefit, because the proposed approach does not require any additional roadside-deployed hardware provided and maintained by public agencies.

For its CV applications and project architecture development, the project will use the Connected Vehicle Reference Implementation Architecture (CVRIA), which provides a definition and typical Physical, Logical, and Communications Diagrams for each CV application, (<http://www.iteris.com/cvria>).

During the Concept of Operations development within the Planning Phase of this project, the details of the CV subsystem will be finalized.

### 5.6. Parking Management

Most cities have sufficient parking inventory and based on the studies conducted for the Dallas / Forth-Worth Area is no different. The issue is changing behavior of motorists so that they can find and use the parking inventory efficiently.

Smart Parking involves a fully integrated parking ecosystem that benefits residents, visitors, merchants, and the city. To accomplish this, it is critical that parking is viewed holistically to include on street metered

and non-metered spaces, city-owned off-street parking, as well as private parking supply that is available to the public.

Smart Parking includes not only sensors, but also and more importantly a change in the way parking is understood, managed, and interacts with stakeholders. It gathers real-time data about parking occupancy and payment status. Analytics use these new sources of data to empower city leaders to improve policy and pricing based on real information about supply and demand and enforce that policy more effectively. A Smart Parking system communicates real time information to drivers so that they can make better decisions, locate parking quickly, and pay using modern technology, improving compliance and optimizing the utilization of parking assets.

#### 5.6.1. Solution Cross Reference to Project Goals

The table below cross references to the proposed technologies to use under this project:

**Table 3: Solutions to meet the Goals of the Project**

Goals	Objectives	Proposed Technologies
<b>Improved Operational Efficiency –The ICCS should support data and video sharing to improve operational efficiency.</b>	<ul style="list-style-type: none"> <li>Provide links between systems to share information</li> <li>Provide a video sharing system for operations to view camera images in real time</li> </ul>	<ul style="list-style-type: none"> <li><b>Regional and DART data connectors</b></li> <li><b>Upgrade SCADA</b></li> <li><b>Upgrade InIT</b></li> <li><b>Upgrade Trapeze</b></li> <li><b>Data Hub</b></li> <li><b>DataMart</b></li> <li><b>IEN GUI</b></li> </ul>
<b>Performance Measures: The ICCS should support the development of system-wide performance measures to enhance customer services</b>	<ul style="list-style-type: none"> <li>Provide real-time dashboards and analytics on current operations</li> </ul>	<ul style="list-style-type: none"> <li><b>Data Archiving</b></li> <li><b>Performance Measures</b></li> </ul>
<b>Improved Coordination - The ICCS should provide automated processes between DART departments so that requests are automated and</b>	<ul style="list-style-type: none"> <li>Provide response plans for incidents with actions for each affected department</li> <li>Provide a decision support system to assist operations in</li> </ul>	<ul style="list-style-type: none"> <li><b>DSS</b></li> <li><b>Data Hub</b></li> <li><b>IEN GUI</b></li> </ul>

<p>information needed to perform their duties is provided.</p>	<p>selection of appropriate responses to events</p>	
<p><b>Improved incident management – The ICCS should support a DART-wide and integrated approach to the management of incidents, events, and emergencies that occur within the DART service area or that otherwise impact the operation of the ICCS, including planning, detection and verification, response and information sharing, such that DART services return to “normal.”</b></p>	<ul style="list-style-type: none"> <li>▪ Provide/expand means for communicating consistent and accurate information regarding incidents and events between DART Operations and public safety agencies.</li> <li>▪ Provide an integrated and coordinated response during major incidents and emergencies.</li> <li>▪ Deploy Mobile Video systems during special events and major incidents that can be used to better monitor operations</li> </ul>	<ul style="list-style-type: none"> <li>▪ <b>DSS</b></li> <li>▪ <b>IEN GUI</b></li> <li>▪ <b>DataHub</b></li> <li>▪ <b>Consolidated DART</b></li> <li>▪ <b>Video Analytics</b></li> </ul>
<p><b>Improved travel information – The ICCS should support improved system-wide traveler information services by supporting the delivery of timely, accurate and reliable information, which then allows travelers to make informed choices regarding departure time, mode and route of travel.</b></p>	<ul style="list-style-type: none"> <li>▪ Facilitate intermodal transfers and route and mode shifts</li> <li>▪ Increase transit ridership</li> <li>▪ Provide accurate real-time information on bus bridges, timing and routes</li> </ul>	<ul style="list-style-type: none"> <li>▪ <b>SMART kiosks</b></li> <li>▪ <b>DataMart</b></li> </ul>
<p><b>Improve System Intelligence – The ICCS should provide a more intelligent approach to system alarms and notifications that reduce cognitive workload for operators.</b></p>	<ul style="list-style-type: none"> <li>▪ Provide neural engine to assist with alarms within the appropriate operating systems within DART (IT, Operations, Maintenance)</li> </ul>	<ul style="list-style-type: none"> <li>▪ <b>DSS</b></li> <li>▪ <b>Video Analytics</b></li> <li>▪ <b>Parking Management</b></li> <li>▪ <b>Video Sharing</b></li> <li>▪ <b>IEN GUI</b></li> </ul>
<p><b>Improve Monitoring and Surveillance of DART Operation Infrastructure</b></p>	<ul style="list-style-type: none"> <li>▪ <b>Deploy additional technologies for safety on buses</b></li> </ul>	<ul style="list-style-type: none"> <li>▪ <b>MobileEye</b></li> <li>▪ <b>Video Detection</b></li> <li>▪ <b>Connected Vehicle Application</b></li> </ul>

## 6. Deployment Plan

This section describes some of the high-level tasks and considerations that will be addressed during the deployment of the project.

### 6.1. Deployment sequencing in stages

Once the planning and design phase of the project is completed, we expect the deployment of the components/subsystems of the solution to be deployed in a staged logical and systematic manner.

The solutions described above to be deployed in the following order:

#### 6.1.1. Deployment - Stage 1

Stage 1 will include the systems that are already well known and available from the systems integration team. The Data Fusion Environment will provide the databases that will be used by all the other systems. As discussed previously, some of the Data Interfaces have already been developed and will be integrated into the ATCMTD. The Response Plan development will begin at this phase, and the rules engine will be created based on those rules.

#### 6.1.2. Deployment - Stage 2

Stage 2 will focus on the additional Data Interfaces and deployment of the predictive model along with other components of the decision support system. The Performance Measures system will be deployed and the

reports and dashboard work can begin. The Event Management Module will be configured to provide the notification and alerts to the agency stakeholders for coordination of response plans.

#### 6.1.3. Deployment - Stage 3

Stage 3 is the final step in deployment of the decision support system with the integration and calibration of the components deployed in Stages 1 and 2. The new technologies for the project will be deployed including the MobileEye, the Parking Management System, and the connected vehicle technology. The management systems for these will be deployed so that the final data interfaces can be developed and deployed in Stage 4.

#### 6.1.4. Deployment - Stage 4

The final deployment phase of the project will include the data interfaces for the systems deployed in Phase 3.

### 6.2. Long Term Operations and Maintenance

It is anticipated that each agency will be tasked to operate and maintain the systems that are deployed within their jurisdiction. The team will examine areas where it may be necessary for specific vendors to operate and maintain their systems for at least a start-up/shake down period. DART and the Regional partners will work to ensure that any needed O&M funds are programmed onto the TIP as this project advances. The following table provides additional detail:

**Table 4: Long-Term Maintenance**

<b>System</b>	<b>Proposed Maintainer</b>
<b>Multi-modal Information Exchange Network (IEN)</b>	Kapsch/DART
<b>Data Hub and Data Fusion Environment</b>	Kapsch/DART
<b>Data Interfaces</b>	Kapsch/DART
<b>Performance Measures</b>	Kapsch/DART
<b>MobileEye – Safety Application</b>	Kapsch/DART
<b>Integrated Corridor Management System</b>	Kapsch/DART
<b>Parking Management System</b>	DART
<b>Decision Support System</b>	Kapsch/DART
<b>Connected Vehicles System</b>	DART
<b>Transit AVL/APC</b>	DART
<b>Smart Kiosk</b>	DART / Selected Vendor
<b>Video Management</b>	DART / Kapsch

## 7. Regulatory, Legislative, or Institutional Challenges

It is not anticipated that there will be any major regulatory or legislative challenges to be addressed. Anticipated institutional challenges include:

- Coordination of the number of regional stakeholders;
- Integration of the wide variety of legacy systems;
- Development and implementation of a new technology system;
- Developing new operational policies and procedures for control center personnel.

Many of the everyday operational processes and procedures are not formally documented and are learned and shared through hands-on experience. Capturing this knowledge and documenting it will assist with knowledge transfer to the next generation of operations managers, controllers, dispatchers, liaisons, and supervisors. This requires a business engineering initiative that is supported and governed by DART senior executives. Capturing this expert knowledge becomes the basis for establishing the rules within the ICCS

processing algorithms to identify incidents and response plans.

DART’s extensive experience in developing, coordinating, implementing and operating similar complex technology projects will greatly facilitate overcoming these challenges.

## 8. System Performance Improvement

System performance improvements will be realized as a result of the various projects that are within the goals of the study. The following performance improvements are expected as a result.

### 8.1. Improved Information Sharing

Through improved information sharing more efficient operations can be expected. This will be accomplished with an integrated information system and a video sharing system that will assist with decision making using video analytics. Automation within the ICCS will take advantage of active and passive alert monitoring, system events, and automated customer communications coming from and going to various systems including field

operations, fare enforcement, AVL, Public Announcement / Visual Message Board (PA/VMB), SCADA, Traffic Signal Priority (TSP), parking, mobile apps, and data portals.

## 8.2. Improved Performance Measures

The ICCS will enhance the collection of performance measures. This will be accomplished through the development of system-wide performance measures to enhance customer services. Business Intelligence integrated with enterprise reporting will provide key service performance indicators that can be distributed throughout DART based on departmental and enterprise goals and objectives. This information will be readily available to support real-time, historical, and modeling informational. Each individual system will be responsible for collecting system-specific data related to each of the designated performance measures and providing this data to the central data repository for processing, aggregation, and archiving for historical purposes. The business intelligence toolset is then able to build the dashboards and portals for each level of management of the system for real-time oversight of the transit services.

## 8.3. Improved Coordination.

The ICCS will improve coordination and decision support by providing automated processes between DART departments. As a result, requests will be automated and information needed to perform duties will be provided. This will provide response plans for incidents with actions for each affected department. Service Quality will be enhanced through ICCS automation and ICCS pre-programmed reminders to staff. Existing capabilities will be improved by expanding and enriching multimodal transportation solutions, real-time traveler information, personal travel assistant apps, integrated fare management, and real-time traffic management.

## 8.4. Improved Incident Response.

The collection of real-time data and visualizations will optimize and improve decision support to incidents and events. This will be supported with mobile applications for DART operations, a mobile video system and pre-developed response plans. These capabilities will enhance the speed, efficiency and operation of event clearance, traffic mitigation and recovery. Communications, systems, and system networks will be integrated to support the consolidated Transit Management Center. Voice, data, video, information, and control will be provided to all departments based on the adopted protocols and standards for the sharing of information and the distribution of responsibilities. The DART Integrated Command and Control System will connect the departmental staffs on a real-time basis via communications and other technologies.

## 8.5. Improved Travel Information

The ICCS will support improved system-wide travel information services by supporting the delivery of timely, accurate and reliable information, which will allow travelers to make informed choices regarding departure time, mode and route travel.

# 9. Safety, Mobility, and Environmental Benefits

Integrating advanced communications in technology into the DART infrastructure will improve the safety, mobility, and environmental impacts of the system and surrounding environments. Indirect measures will be most realized with the implementation of the ICCS. These include, improved incident management, improved on-time performance, and traveler information.

The ICCS will provide data integration of DART systems for the operation and maintenance of the transit system. By automating the information flows between

systems, DART can improve the efficiency of its internal operations and its services to its customers.

### 9.1. Safety Benefits

The impact of the ICCS on Safety will be evaluated to confirm the system deployed and the management strategies used will have a positive impact on the region. Performance measures that will be evaluated include: motor vehicle crash rates, motor vehicle fatality rates, motor vehicle injury rates; light-rail vehicle crash rates, light-rail vehicle fatality rates, light-rail vehicle injury rates; bus crash rates, bus fatality rates, bus injury rates; reduction in incident response and recovery time, and public perceptions will also be considered.

### 9.2. Mobility Improvements.

With improved light-rail, commuter-rail, and bus operational efficiency, various mobility benefits are realized. Improved incident management is expected with a more comprehensive and accurate performance of the network system. Incident management for planned and unplanned service challenges will be supported in a systematic enterprise approach. The management of incidents, events, and emergencies that occur within the DART service area, or that otherwise impact the operation of the ICCS, will be applied in a uniform and consistent manner based upon approved business practices. The ICCS will provide the detection and verification, response and information sharing, such that DART services return to “normal”. This will be achieved through coordinated responses, video analytics, and real-time decision making.

What the ICCS does best is improve system intelligence. Current DART systems provide many alarms and notifications; some processes could be managed through machine learning by utilizing a neural engine to learn how to process and handle alarms within the operations of the systems. Using data analytics, the neural engine can review an event and evaluate response

times, actions taken, actions not taken, and the effects of these actions on the total DART service. The system can recognize patterns and associate results to actions taken and make recommendations to improve the flows of information and organization of business processes.

Several performance measures will be tracked to determine the actual impact. These include travel time reliability for light-rail trains, commuter trains, and bus travel. In addition, enhanced managing capacity across modes by utilizing ICM strategies that inform travelers of wait times, connection information, and travel time of routes which will thereby reduce travel demand and improve travel reliability.

### 9.3. Environmental Benefits.

Carbon dioxide makes up 95% of all transportation-related greenhouse gases. CO<sub>2</sub> is emitted from cars, SUVs, and truck that use gasoline, diesel, and other fuels. Public transportation can play a significant role in reducing these emissions as national averages show it produces lower greenhouse gas emission per passenger mile than personal cars. It is estimated that light rail produces 62% less and bus transit produce 33% less.

With the enhanced operational efficiency, the ICCS will bring to the DART system, more public transportation ridership is expected. The impact of this is continued reduction of environmental impacts.

## 10. Vision, Goals, and Objectives

The vision of the ICCS is to optimize operational efficiency and enhance the customer experience by taking advantage of DART’s workforce, assets, technology, and real estate.

**The ICCS goals and objectives are provided in Table 5.** They are interrelated such that activities and strategies oriented towards

attaining one of the Goals will likely impact the attainment of other goals and objectives.

**Table 5: Goals and Objectives Relationship**

Goals	Objectives
Improved Operational Efficiency –The ICCS should support data and video sharing to improve operational efficiency.	<ul style="list-style-type: none"> <li>▪ Provide links between systems to share information</li> <li>▪ Provide a video sharing system for operations to view camera images in real time</li> </ul>
Performance Measures: The ICCS should support the development of system-wide performance measures to enhance customer services	<ul style="list-style-type: none"> <li>▪ Provide real-time dashboards and analytics on current operations</li> </ul>
Improved Coordination - The ICCS should provide automated processes between DART departments so that requests are automated and information needed to perform their duties is provided.	<ul style="list-style-type: none"> <li>▪ Provide response plans for incidents with actions for each affected department</li> <li>▪ Provide a decision support system to assist operations in selection of appropriate responses to events</li> </ul>
Improved incident management – The ICCS should support a DART-wide and integrated approach to the management of incidents, events, and emergencies that occur within the DART service area or that otherwise impact the operation of the ICCS, including planning, detection and verification, response and information sharing, such that DART services return to “normal.”	<ul style="list-style-type: none"> <li>▪ Provide/expand means for communicating consistent and accurate information regarding incidents and events between DART Operations and public safety agencies.</li> <li>▪ Provide an integrated and coordinated response during major incidents and emergencies.</li> <li>▪ Deploy Mobile Video systems during special events and major incidents that can be used to better monitor operations</li> </ul>
Improved travel information – The ICCS should support improved system-wide traveler information services by supporting the delivery of timely, accurate and reliable information, which then allows travelers to make informed choices regarding departure time, mode and route of travel.	<ul style="list-style-type: none"> <li>▪ Deploy Customer Information Kiosks to provide travel/transit information as it relates to DART services, as well as Wi-Fi for customers, emergency notifications, and more.</li> <li>▪ Facilitate intermodal transfers and route and mode shifts</li> <li>▪ Increase transit ridership</li> <li>▪ Provide accurate real-time information on bus bridges, timing and routes</li> </ul>
Improve System Intelligence – The ICCS should provide a more intelligent approach to system alarms and notifications that reduce cognitive workload for operators.	<ul style="list-style-type: none"> <li>▪ Provide neural engine to assist with alarms within the appropriate operating systems within DART (IT, Operations, Maintenance)</li> </ul>

## 11. Partnership Plan

The following private companies have partnered with DART to prepare information for this project:

- **Kapsch TrafficCom Transportation (Kapsch)** – Kapsch will be our overall consultant lead in charge of project management, system integration, deployment and O&M services.
- **Lawson** – Human resource, payroll, and procurement and supply chain management.
- **DriveCam / SmartDrive** – Driver performance.
- **Unwire** – Mobile messaging and ticketing.
- **Everbridge** – Incident Response and E-alerts.
- **SCADA – GE** – Train supervisory control and data acquisition. Rail signals, electrification, and tunnel ventilation.
- **Harris and Trapeze** – Open sky radio and computer aided dispatch.
- **VBS Init** – Rail computer aided dispatch. Light rail vehicle tracking and management, street car tracking and management.
- **Trapeze** – Driver assignment for bus and light rail vehicle.
- **IBM Cognos** – Business intelligence for reporting, analytics, and financial analysis.
- **Tableau** – Analytics, and visual data analysis.
- **Spear** – Maintenance asset management system.
- **Verizon Wireless** – Customer Information Kiosk
- **AT&T** – Customer Information Kiosk

## 12. Leverage Existing Investments

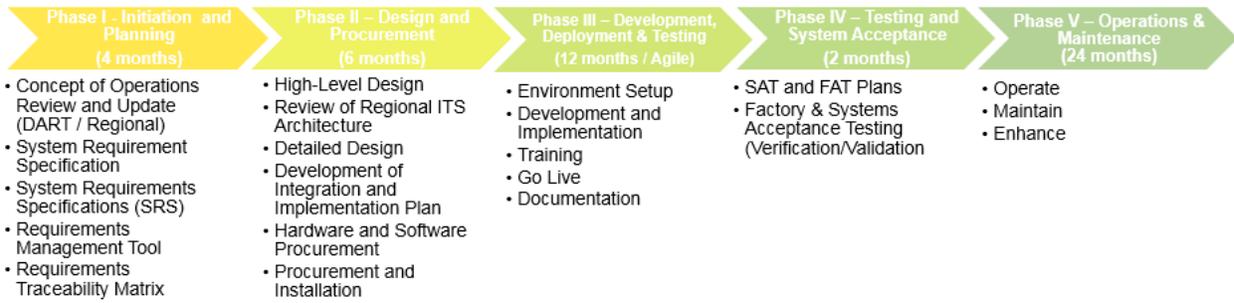
DART operates in the largest metropolitan area in Texas that includes the longest light rail system in the U.S. DART is an innovative industry leader advancing new models for local bus and paratransit service and customer-facing communication technology and service. DART has invested in industry leading operations and management software systems. DART is positioned to enhance their multi-modal coordination by leveraging their investments with the addition of an ICCS that will provide decision support, simulation, feedback and real-time reporting.

Multi-modal Service Coordination is an ITS architecture Service Package that establishes communications between and within multiple transit and traffic agencies to improve service coordination. Multimodal coordination between and within transit agencies can increase traveler convenience at transit transfer points and clusters (a collection of stops, stations, or terminals where transfers can be made conveniently) and improve operating efficiency.

The ICCS falls within this Service Package and becomes the collection of systems working together using the architecture flows to connect to other important external systems. The ICCS directly relates to the ITS strategies used to meet DART's ITS regional goals and objectives

## 13. Schedule

We are proposing a 4-year schedule, with a 24-month planning/design/build phase followed by a 24-month Operations and Maintenance phase.



**Figure 7: Proposed Project Schedule**

**13.1.1. Phase 1: Planning Phase**

For the planning phase of the project, a Concept of Operations document and Requirements document will be the primary deliverables. Following the FHWA Systems Engineering process, a Project Management Plan (PMP) and Systems Engineering Management Plan (SEMP) will also be provided. Leveraging the existing programs in the Region, we expect the Planning Phase to take about 4 months.

**13.1.2. Phase 2: Design Phase**

Our experience has shown that a hybrid waterfall and agile process is appropriate for projects which have well know elements and less known elements. For this phase, the well-defined elements which our Systems Integrator has previous experience deploying will be identified and designed. This phase will also identify the elements which will be design & developed during the Agile Deployment phase. All elements designed during the Design phase 1 will be developed during the Phase 3 integration build.

**13.1.3. Phase 3: Design-Build Phase (Agile Deployment)**

Since some of the data used for the system will be new, an agile development process will be followed. We currently expect three iterations of the build to be designed, prior to a final Integration build which will be used for the Systems Acceptance Test (SAT). Our goal is to

have an operational system within 12 months after the planning phase is complete.

**13.1.4. Phase 4: Testing and System Acceptance**

Testing is an activity embedded as an integral part of our software and system development methodology as well as final deployment and start of operations. Implementation includes unit coding, unit testing, unit integration, and integration testing. The final step in testing, once the Unit and Integration testing is complete is the System Acceptance Testing (SAT). The SAT plan and scripts will be developed by the consultant team, and reviewed and approved by the stakeholders. Once the SAT readiness review is completed, the SAT will be completed by a group identified by the stakeholders to test the system and “accept” it for operations.

**13.1.5. Phase 5: Operations and Maintenance Phase**

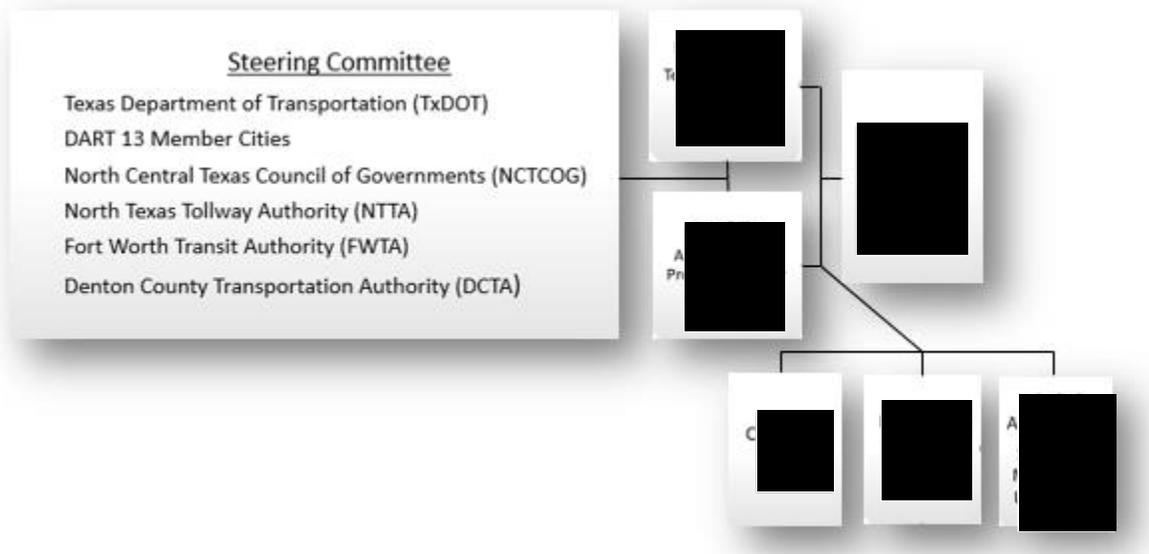
Following the ICM program’s model, we are proposing a 6-month “soft launch” of the system to test and modify the operational processes prior to a 24-month full O&M phase.

## 15. Support of USDOT ITS Initiatives

The ICCS System project supports the majority of the USDOT's ITS Program initiatives for Safety, Mobility, Environment, Road Weather,

Intermodal Research, and Connected Vehicle Technology. DART will leverage the lessons learned, and knowledge technology transfer initiatives provided by USDOT to ensure that our project is consistent with USDOT policy and programs.

### ii. Staffing Description



### 1. Organization and Key Personnel

The DART organization will provide high-level organization for the management and implementation of this project. Participating staff for this project include:

#### 1.1.1. Participating Staff

- [Redacted]
- [Redacted]
- [Redacted]

### 2. Primary Point of Contact

The point-of-contact for our proposal is:

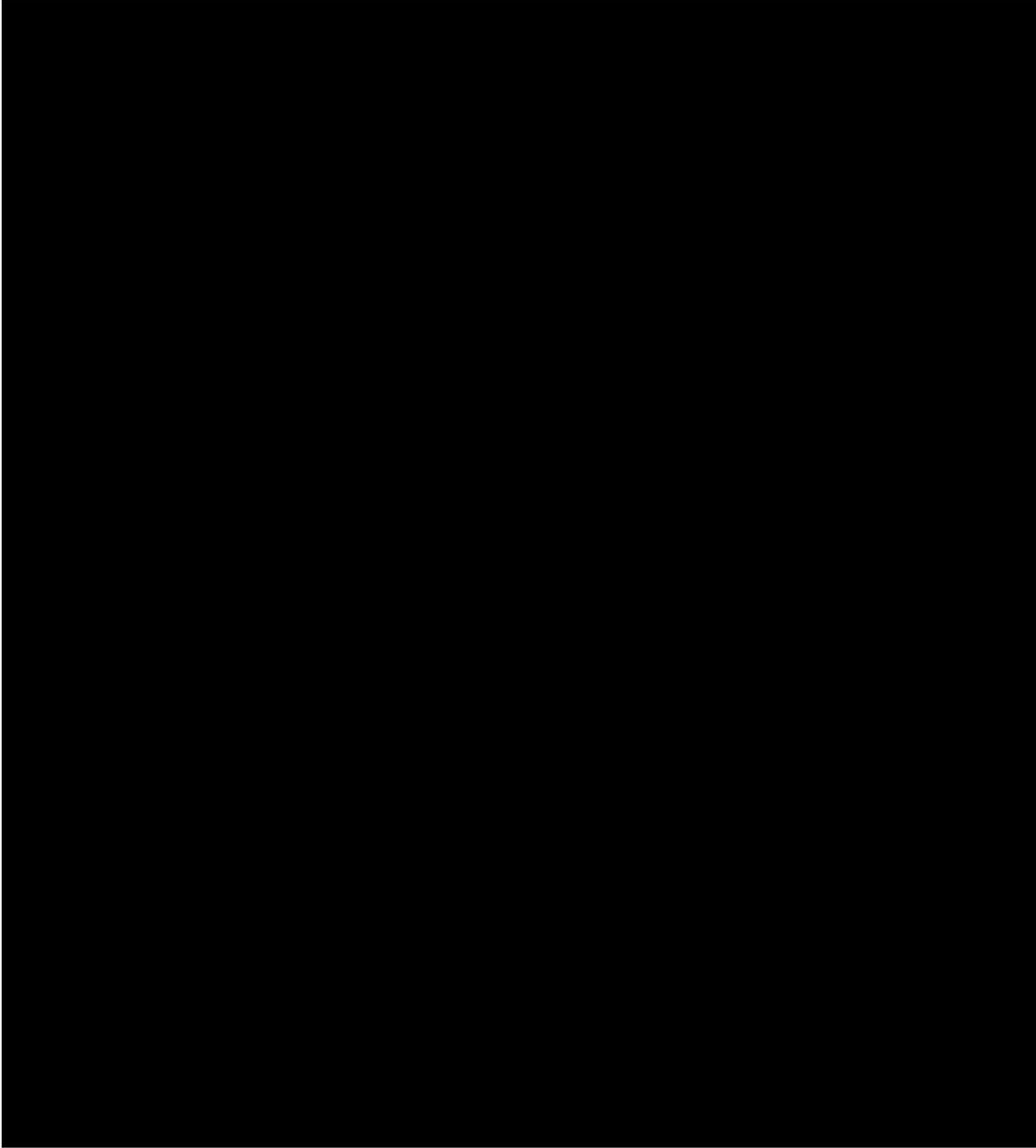
Todd Plesko  
Vice President, Planning and Development  
Dallas Area Rapid Transit  
1401 Pacific Ave, Dallas, TX 75226  
Phone: (214) 749-2750 / Email:  
[tplesko@dart.org](mailto:tplesko@dart.org)

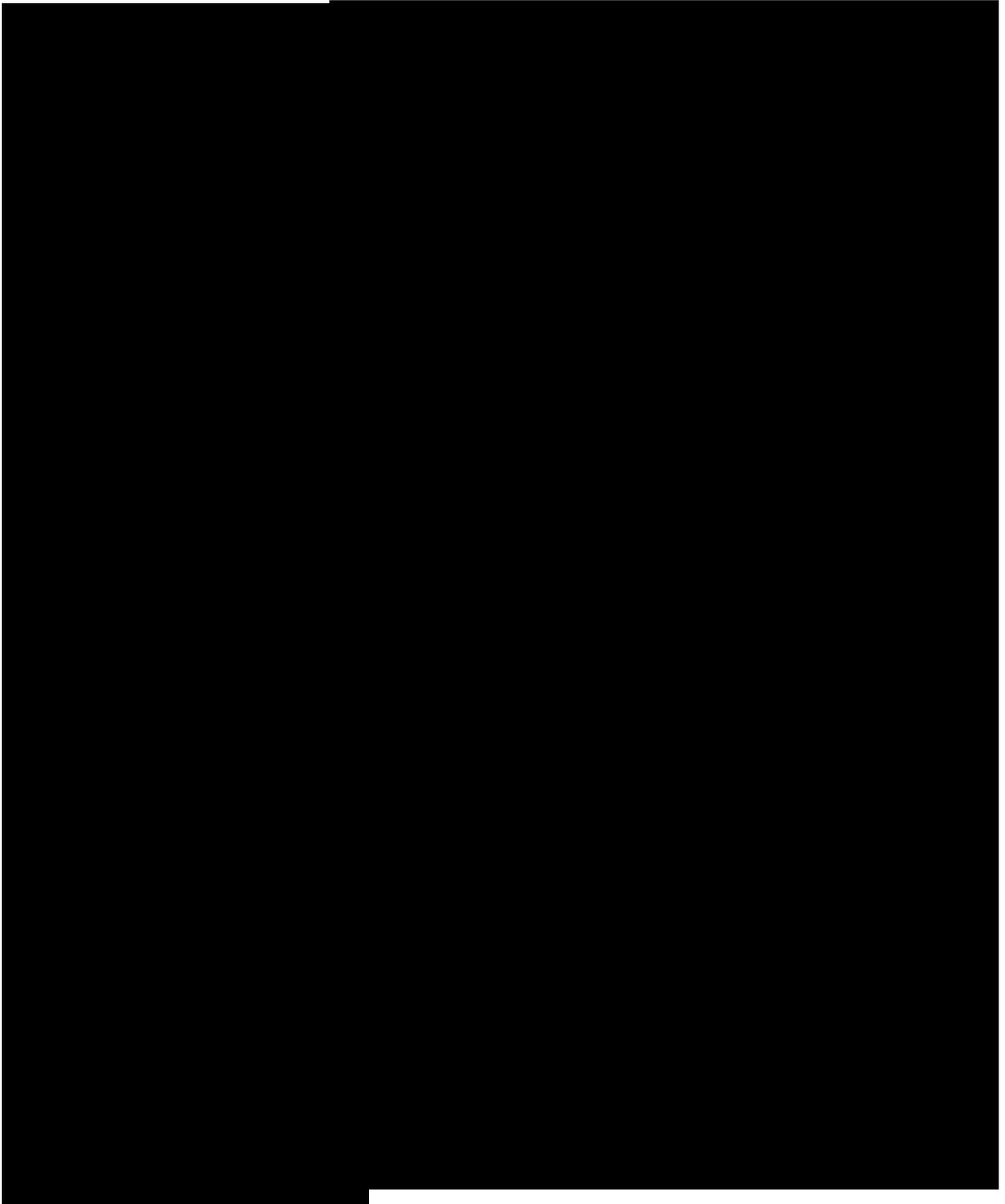
### 3. Resumes

The following pages include full resumes of the key personnel that will be included in the organization on this project.

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