



UNITED STATES
DEPARTMENT OF TRANSPORTATION



Dynamic Low Emissions Zones Concept of Operations (ConOps)

**Applications for the Environment: Real-Time
Information Synthesis (AERIS) Program**

Fall/Winter Webinar Series

December 12th, 2012

Presentation Overview

1. Background and Description of Current Situation
2. Limitations of Current Systems
3. Dynamic Low Emissions Zone Transformative Concept
4. Scenarios
5. Goals, Objectives, and Performance Measures

The Dynamic Low Emissions Zones ConOps

- Provides an operational description of “how” the Transformative Concept may operate.
- Communicates user needs and desired capabilities for and expectations of the Dynamic Low Emissions Zones Transformative Concept .
- Builds consensus among AERIS user groups and stakeholders concerning these needs and expectations.
 - USDOT
 - State and Local Departments of Transportation (DOTs)
 - Regional Planning Organizations
 - The Automotive Industry
 - ITS Developers, Integrators, and Researchers
- Serves as a guideline moving forward with research and development of AERIS applications.



1. BACKGROUND AND DESCRIPTION OF CURRENT SITUATION



Most Polluted Cities | American Lung Association

Over **127 million people** live in counties that receive an F for pollution.



Mapping of Most Polluted U.S. Cities

Nearly 6.4 million people (2.1%) in the United States live in an area with unhealthy year-round levels of particle pollution.

These people live in areas where chronic levels are regularly a threat to their health..

Nearly 4 in 10 people in the United States (38.5%) live in areas with unhealthy levels of ozone.

Counties that were graded F for ozone levels have a combined population of almost 116.7 million.

Nearly one in six (16.1%) people in the United States live in an area with unhealthy short-term levels of particle pollution.

Nearly 50 million Americans live in 66 counties that experienced too many days with unhealthy spikes in particle pollution. Short-term spikes in particle pollution can last from hours to several days and can increase the risk of heart attacks, strokes and emergency-room visits for asthma and cardiovascular disease, and most importantly, can increase the risk of early death.

Most Polluted Cities | American Lung Association

OZONE	
#1	Los Angeles-Long Beach-Riverside, CA
#2	Visalia-Porterville, CA
#3	Bakersfield-Delano, CA
#4	Fresno-Madera, CA
#5	Hanford-Corcoran, CA
#6	Sacramento-Arden Arcade-Yuba City, CA
#7	San Diego-Carlsbad-San Marcos, CA
#8	Houston-Baytown-Huntsville, TX
#9	San Luis Obispo-Paso Robles, CA
#10	Merced, CA
#11	Modesto, CA
#12	Dallas-Fort Worth, TX
#13	Washington-Baltimore-Northern Virginia, DC-MD-VA-WV
#14	El Centro, CA
#15	New York-Newark-Bridgeport, NY-NJ-CT-PA

YEAR ROUND PARTICLE POLLUTION	
#1	Bakersfield-Delano, CA
#2	Hanford-Corcoran, CA
#3	Los Angeles-Long Beach-Riverside, CA
#4	Visalia-Porterville, CA
#5	Fresno-Madera, CA
#6	Pittsburgh-New Castle, PA
#7	Phoenix-Mesa-Glendale, AZ
#8	Cincinnati-Middletown-Wilmington, OH-KY-IN
#9	Louisville-Jefferson County-Elizabethtown-Scottsburg, KY-IN
#10	Philadelphia-Camden-Vineland, PA-NJ-DE-MD
#10	St. Louis-St. Charles-Farmington, MO-IL
#14	Indianapolis-Anderson-Columbus, IN
#14	Fairbanks, AK
#14	Cleveland-Akron-Elyria, OH

SHORT TERM PARTICLE POLLUTION	
#1	Bakersfield-Delano, CA
#2	Fresno-Madera, CA
#3	Hanford-Corcoran, CA
#4	Los Angeles-Long Beach-Riverside, CA
#5	Modesto, CA
#6	Pittsburgh-New Castle, PA
#7	Salt Lake City-Ogden-Clearfield, UT
#8	Logan, UT-ID
#9	Fairbanks, AK
#10	Merced, CA
#11	Provo-Orem, UT
#12	Visalia-Porterville, CA
#13	Eugene-Springfield, OR
#14	Green Bay, WI
#15	Stockton, CA

Source: "2012 State of the Air", The American Lung Association
<http://www.stateoftheair.org/2012/city-rankings/most-polluted-cities.html>

Strategies for Reducing Surface Transportation-Related Emissions

Strategy #1

Vehicle Technology

- Improve the energy efficiency of the vehicle fleet by implementing more advanced technologies

Strategy #2

Fuel Technology

- Reduce the carbon content of fuels through the use of alternative fuels (for instance, natural gas, biofuels, and hydrogen)

Strategy #3

Travel Activity

- Reduce the number of miles traveled by vehicles, or shift those miles to more efficient modes of transportation

Strategy #4

Vehicle and System Operations

- Improve the efficiency of the transportation network so that a larger share of vehicle operations occur in favorable conditions, with respect to speed and smoothness of traffic flow, resulting in more fuel efficient vehicle operations



Case Study: London's Low Emissions Zone

How It Works

- Static road signs alert drivers when they are entering or leaving the low emissions zone.
- Closed circuit television (CCTV) cameras capture license plate numbers, and automatic license plate recognition (ALPR) technology uses optical character recognition software to identify vehicles by their license plates.
- System software compares them to a database of vehicles that meet the emissions standards to analyze whether payment is required.
- The system informs officials if a vehicle meets the emissions standards, is exempt, is registered for a discount or if the owner has already paid the daily charge.

Benefits

- According to a 2006 study, concentrations of small particles from traffic sources were expected to decrease across London by 4.3 percent in 2008 and 8.0 percent in 2010 due to the Low Emissions Zone, and NO_x was expected to decrease by 3.2 percent in 2008 and 4.1 percent in 2010.



3. LIMITATIONS OF CURRENT SYSTEMS

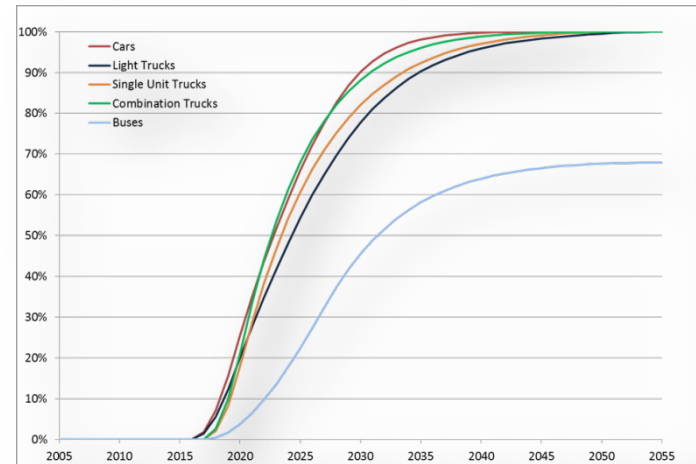
Limitations of Current Systems

1. Limited geographically by tolling and other roadside infrastructure
2. Not flexible in size, location, nor the time they are operational
3. Do not consider real-time traffic and environment data when establishing parameters for the Low Emissions Zone
4. Emissions data are not collected from vehicles
5. Do not determine fees for entering the Low Emissions Zone based on vehicle specific data
6. Do not consider incentives to drivers practicing eco-driving strategies
7. Limited in the data they provide travelers with parameters about the Low Emissions Zone or alternative travel choices for entering the Low Emissions Zone
8. Do not consider restrictions for passenger vehicles or encourage “green” transportation choices like carpooling, vanpooling, and transit.

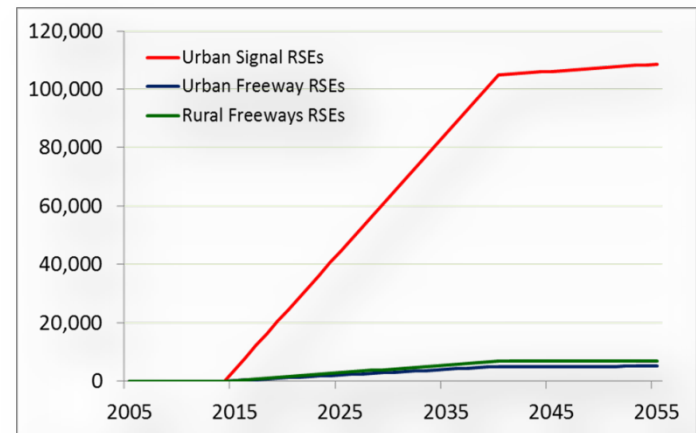


Deployment Rates and Market Penetration

- The market penetration of connected vehicle technologies is expected to take time to achieve comprehensive deployment.
- Infrastructure deployed during this transition must continue to support the environmental needs of non-equipped vehicles while leveraging the capabilities of connected vehicles to realize the benefits of vehicle-to-infrastructure (V2I) communications.
- The first generation of V2I applications will build upon current infrastructure systems for non-equipped vehicles, while at the same time providing data and information to connected vehicles to support better situational awareness and more informed decisions.



Estimated OBE Deployment Rate



Estimated RSE Deployment Rate



Arterial Data
Environments



4. DYNAMIC LOW EMISSIONS ZONES TRANSFORMATIVE CONCEPT

Freeway Data
Environments

Dynamic Low Emissions Zones

- **Similar to today's ITS:** cordons with fixed infrastructure (e.g., London's Congestion Pricing)

- **Imagine tomorrow's connected vehicle:**
 - Connected vehicle technology allowing for Low Emissions Zones that can be:
 - Scalable and moveable (e.g., pop-up for a day, removable, flexible)
 - Not dependent on conventional ITS infrastructure
 - Dynamic based on real-time vehicle emissions data collected from vehicles and other sources
 - Dynamic Low Emissions Zones that provide incentives to drivers who practice “eco-driving” within the Low Emissions Zone.
 - Dynamic Low Emissions Zones that encourage “green” transportation choices, including transit options and freight operations.



Dynamic Low Emissions Zones

- The Dynamic Low Emissions Zones Transformative Concept includes a geographically defined area and seeks to restrict or deter access by specific categories of high-polluting vehicles into the zone for the purpose of improving the air quality within the geographic area.
- Low Emissions Zones may:
 - Be **permanent**, similar to London's Low Emissions Zone.
 - Provide the capability for the zone to be **dynamic**. Dynamic zones would allow operating entities to change the parameters of the zone based on various criteria including air quality conditions, weather conditions, traffic conditions, or special events.
 - Encourage travel using **transit, carpools, and fuel efficient vehicles**.
 - Consider varying geographic boundaries:
 - Special Event Facility – encouraging mode shift
 - City, County, Metropolitan Area, or State



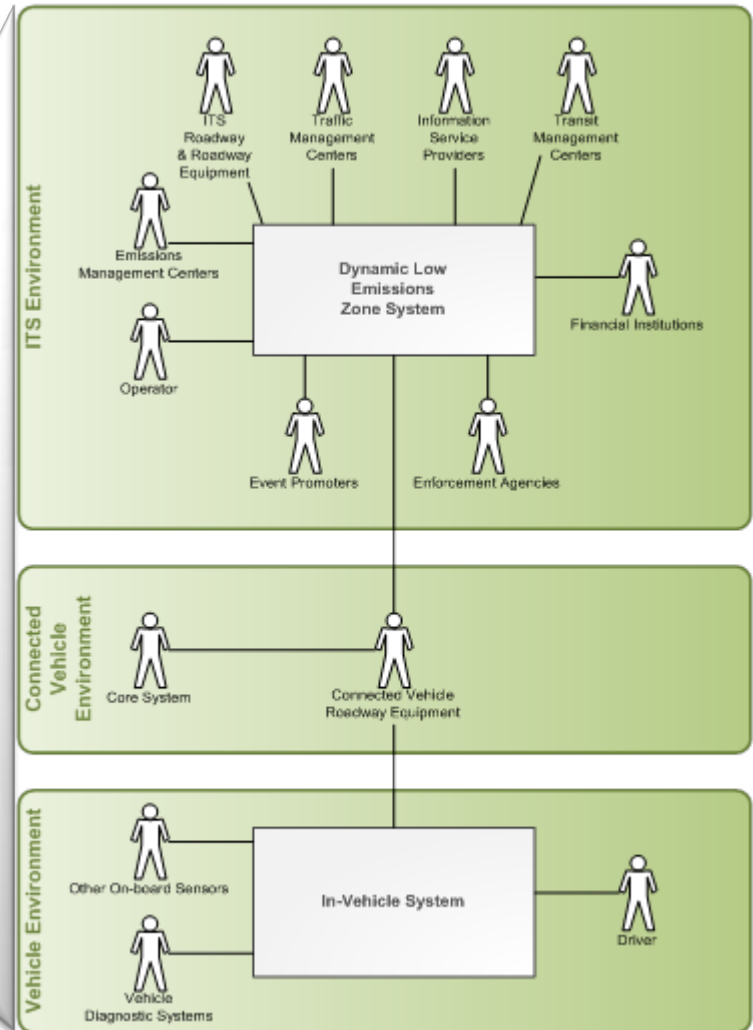
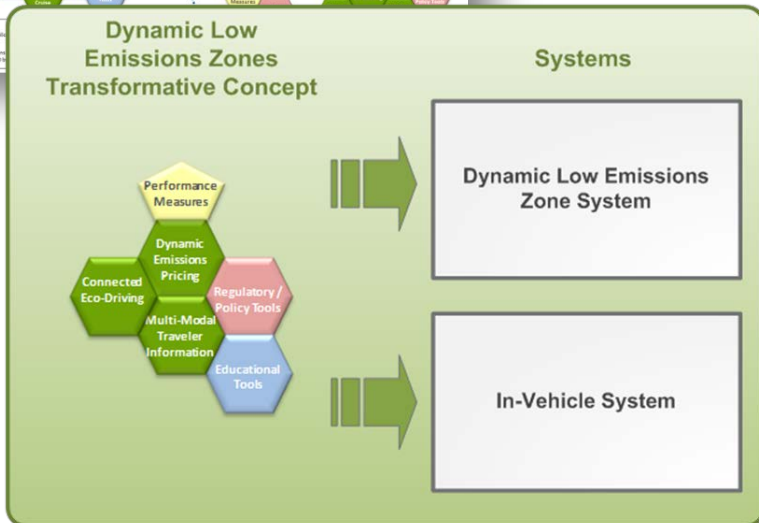
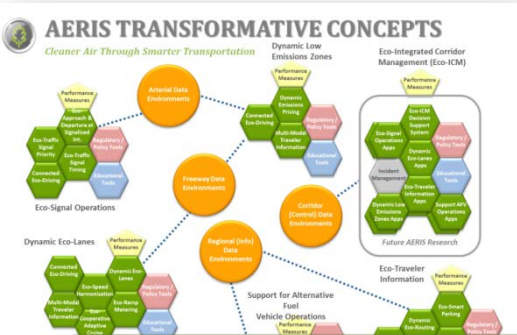
Dynamic Low Emissions Zones

Implementation of Dynamic Low Emissions Zones must include:

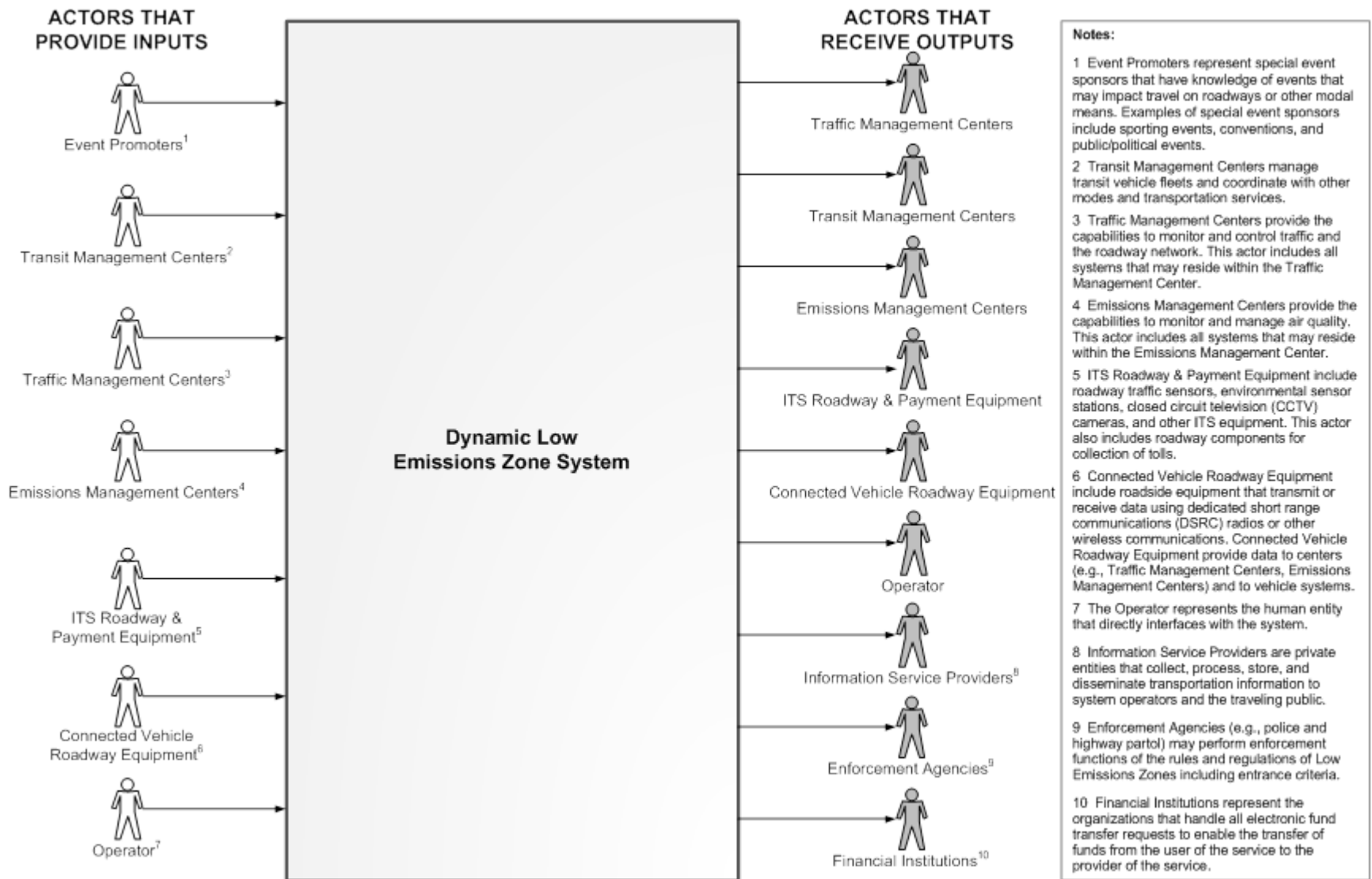
- Sustainable Land Use
- Multi-modal options to travel into or around the Low Emissions Zone
 - Transit
 - Walkable and Bicycle friendly Cities
- Options for Freight to support economic vitality
 - Incentives for Off-Peak Delivery or create a surcharge for peak-hour delivery



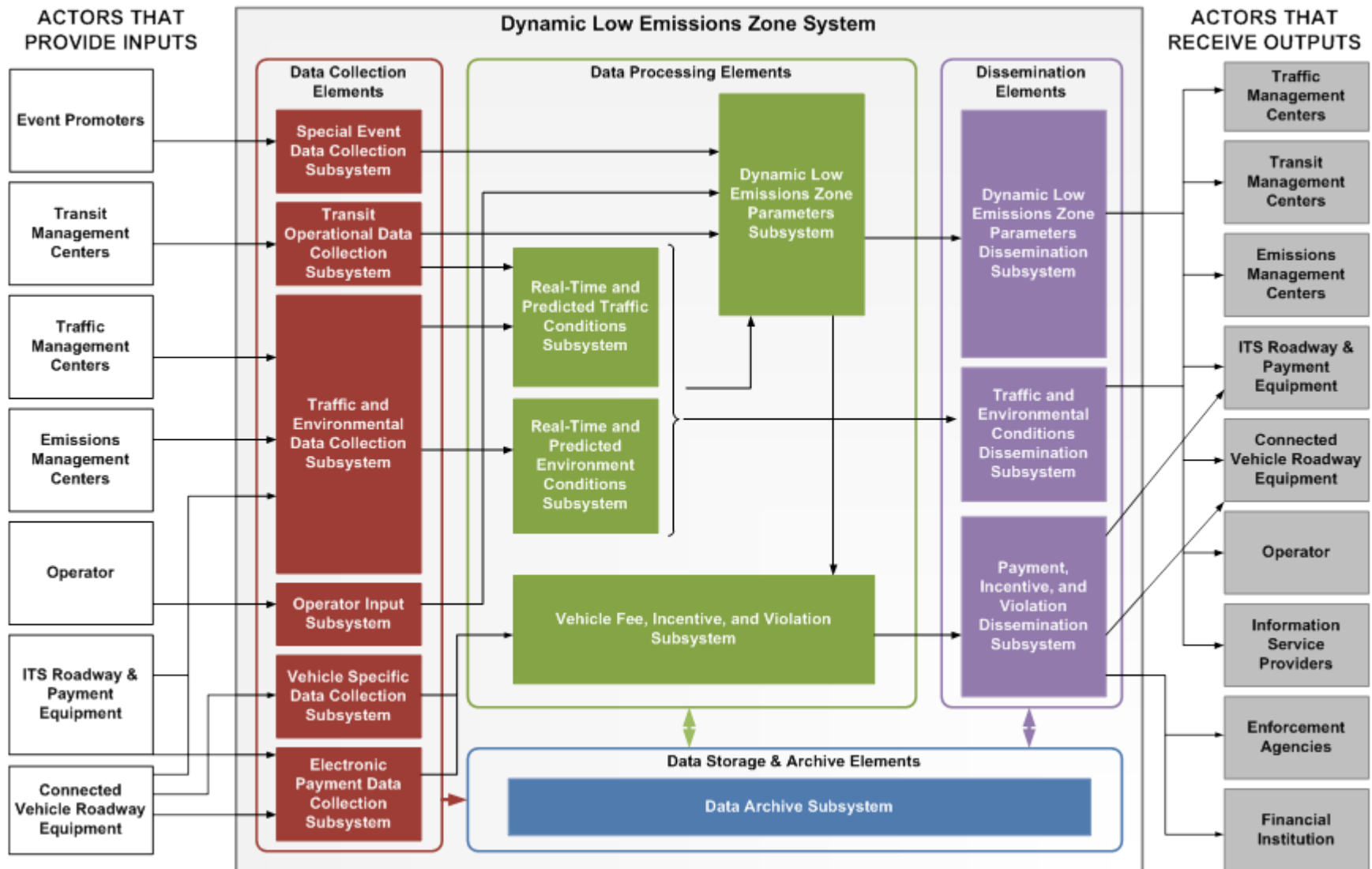
Dynamic Low Emissions Zone Systems



Dynamic Low Emissions Zone System



Dynamic Low Emissions Zone System *(cont'd)*



Dynamic Low Emissions Zone System | Data Collection Needs

ID	TITLE	DESCRIPTION
DLEZS-DC-01	Collect Special Event Data	The Dynamic Low Emissions Zone System needs to collect special event data. Examples of special events include sporting events, conventions, motorcades/parades, and public/political events.
DLEZS-DC-02	Collect Transit Operations Data	The Dynamic Low Emissions Zone System needs to collect data from Transit Agencies about current and planned transit operations, including information about transit routes, services, and ridership.
DLEZS-DC-03	Collect Traffic Data	The Dynamic Low Emissions Zone System needs to collect traffic data (e.g., volume, speed, occupancy, vehicle classification, and incidents).
DLEZS-DC-04	Collect Environmental Data	The Dynamic Low Emissions Zone System needs to collect environmental data (e.g. ambient air quality, emissions, temperature, wind speed, and other road weather information).
DLEZS-DC-05	Collect Operator Input	The Dynamic Low Emissions Zone System needs to collect data entered by personnel operating the system. This allows the operator to manually enter parameters for the Dynamic Low Emissions Zone.
DLEZS-DC-06	Collect Vehicle Specific Data	The Dynamic Low Emissions Zone System needs to collect vehicle-specific data about individual vehicles' parameters. Vehicle specific data may include the vehicle's make and model, engine type, number of axles, average emissions, average fuel consumption, unique identifier (e.g., license plate number or vehicle registration data), the time the vehicle entered the Low Emissions Zone, and number of miles traveled within the Low Emissions Zone.
DLEZS-DC-07	Collect Electronic Payments	The Dynamic Low Emissions Zone System needs to collect data from vehicle payment devices being carried on-board the vehicle and used as a payment instrument.

Dynamic Low Emissions Zone System | Data Processing Needs

ID	TITLE	DESCRIPTION
DLEZS-DP-01	Process Traffic Data	The Dynamic Low Emissions Zone System needs to synthesize traffic data from multiple sources (e.g., fixed sensors, connected vehicle roadway equipment, other centers) to provide traffic analyses aggregated at different levels (e.g., intersection, corridor, and regional levels).
DLEZS-DP-02	Generate Predicted Traffic Conditions & Forecast Demand	The Dynamic Low Emissions Zone System needs to use historical and processed traffic data to predict traffic conditions.
DLEZS-DP-03	Process Environmental Data	The Dynamic Low Emissions Zone System needs to synthesize environmental data from multiple sources (e.g., fixed sensors, connected vehicle roadside equipment, and other centers) to provide emissions analyses.
DLEZS-DP-04	Generate Predicted Emissions Profile	The Dynamic Low Emissions Zone System needs to synthesize environmental data from multiple sources (e.g., sensors, connected vehicle roadside equipment, and other centers) to generate predicted emissions.
DLEZS-DP-05	Create and Decommission Dynamic Low Emissions Zones	The Dynamic Low Emissions Zone System needs to create and decommission Dynamic Low Emissions Zones. The system needs to use data collected from multiple sources (e.g., sensors, connected vehicle roadside equipment, and other centers) to determine whether current or predicted conditions meet the criteria for the Dynamic Low Emissions Zone.

Dynamic Low Emissions Zone System | Data Processing Needs

ID	TITLE	DESCRIPTION
DLEZS-DP-06	Determine Fees for Vehicles	The Dynamic Low Emissions Zone System needs to use data collected from vehicles to determine fees for vehicles to enter the Low Emissions Zone. These fees would be determined based on the Dynamic Low Emissions Zone criteria.
DLEZS-DP-07	Determine Incentives for Individual Vehicles	The Dynamic Low Emissions Zone System needs to use data collected from individual vehicles to determine incentives for individual vehicles in the Low Emissions Zone.
DLEZS-DP-08	Detect Violations for Individual Vehicles	The Dynamic Low Emissions Zone System needs to use data collected from vehicles to determine violations for individual vehicles that illegally entered the Low Emissions Zone. Violations include vehicles entering the Low Emissions Zone without paying the designated fee and vehicles entering the Low Emissions Zone that are prohibited from the zone.
DLEZS-DP-09	Manage Electronic Payment Processing	The Dynamic Low Emissions Zone System needs to maintain a log of all fee and incentive transactions carried out by the system. The system should also maintain data about bad toll payments. The Dynamic Low Emissions Zone System also needs to send details of transactions to the financial institution to enable the travelers to be billed through their credit identities or other information provided when the vehicle was registered for tolling.

Dynamic Low Emissions Zone System |

Dissemination Needs

ID	TITLE	DESCRIPTION
DLEZS-D-01	Disseminate Low Emissions Zone Parameters to Vehicles	The Dynamic Low Emissions Zone System needs to provide parameters about the Low Emissions Zone to vehicles. This information may include the location of the Low Emissions Zone, fee structure, or other parameters about the Low Emissions Zone needed by a driver.
DLEZS-D-02	Disseminate Low Emissions Zone Parameters to Other Centers and ISPs	The Dynamic Low Emissions Zone System needs to provide parameters about the Low Emissions Zone to other centers. Other centers may be adjacent geographically, under control of a different jurisdiction, or part of a more complex hierarchy.
DLEZS-D-03	Disseminate Traffic Conditions to Other Centers and ISPs	The Dynamic Low Emissions Zone System needs to disseminate traffic conditions to other centers to enable coordination of operational strategies for a corridor or a region.
DLEZS-D-04	Disseminate Traffic Conditions to Vehicles	The Dynamic Low Emissions Zone System needs to provide traffic condition messages to vehicles. These messages need to be formatted as output data for in-vehicle signage. These messages should include information that would typically be displayed on a dynamic message sign (e.g., current traffic conditions, predicted traffic conditions, incidents).
DLEZS-D-05	Disseminate Multi-Modal Travel Options	The Dynamic Low Emissions Zone System needs to provide multi-modal travel options to vehicles. These options include information about the locations of transit stops, multi-modal parking facilities, and transit schedules.
DLEZS-D-06	Disseminate Environmental Conditions to Other Centers	The Dynamic Low Emissions Zone System needs to disseminate environmental data (e.g., regional and/or local air quality, temperature, precipitation) to other centers. These data should be shared with other jurisdictions to enable coordination of advisory and operational strategies for a corridor or a region.

Dynamic Low Emissions Zone System |

Dissemination Needs

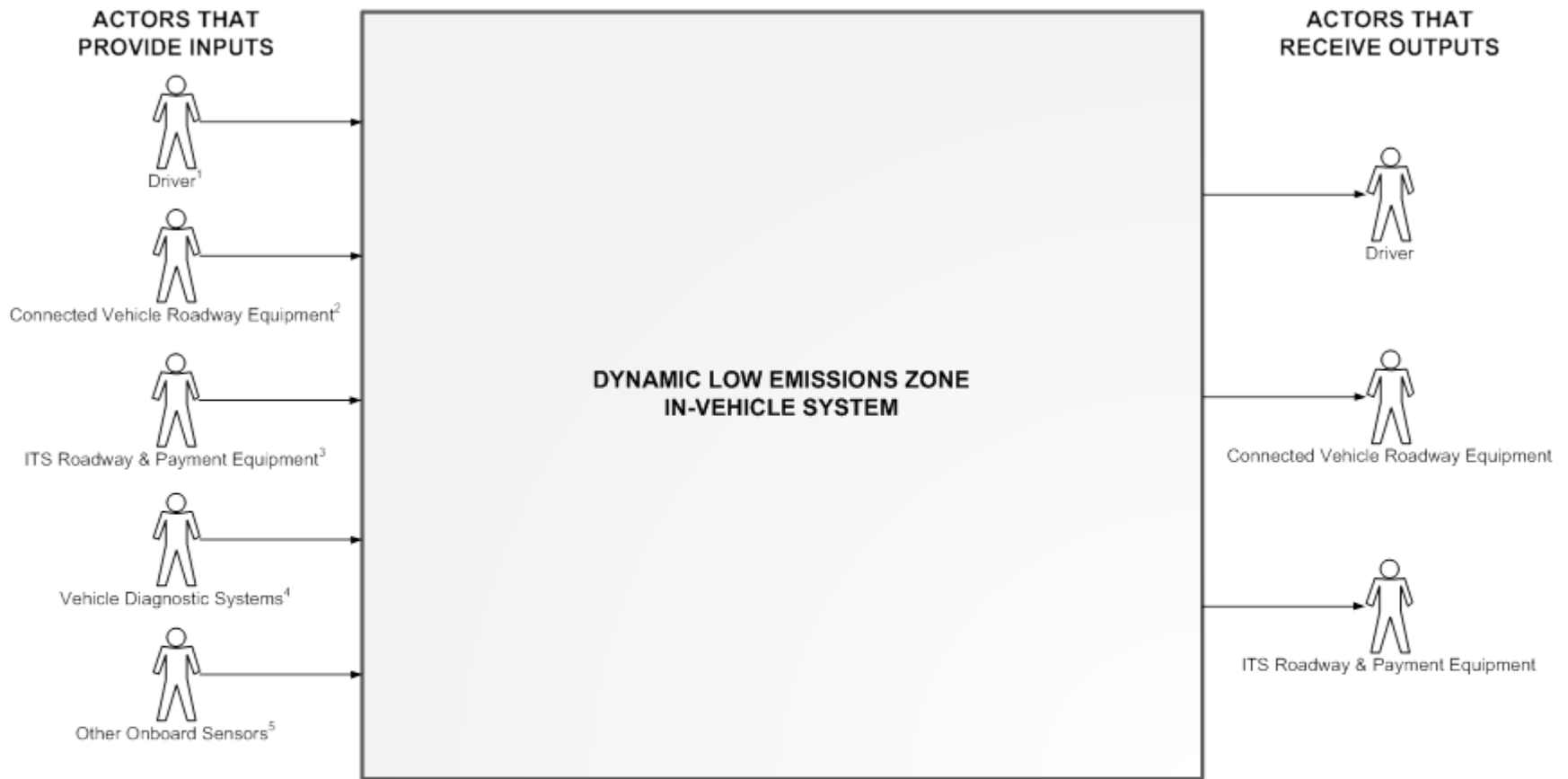
ID	TITLE	DESCRIPTION
DLEZS-D-07	Disseminate Environmental Conditions to Vehicles	The Dynamic Low Emissions Zone System needs to provide environmental conditions messages to vehicles.
DLEZS-D-08	Disseminate Information for Request for Electronic Payment to Individual Vehicles	The Dynamic Low Emissions Zone System needs to disseminate information specific to individual vehicles for electronic payment of tolls. The system needs to request the data from the vehicle payment device being carried on board the vehicle and used as a payment instrument.
DLEZS-D-09	Request for Payment from Financial Institutions	The Dynamic Low Emissions Zone System needs to make requests for payment from Financial Institutions.
DLEZS-D-10	Provide Incentives	The Dynamic Low Emissions Zone System needs to use vehicle specific data collected from vehicles to provide an individual vehicle an incentive.
DLEZS-D-11	Provide Confirmation of Payment or Incentive to Individual Vehicles	The Dynamic Low Emissions Zone System needs to provide confirmation of payment or incentive to individual vehicles.
DLEZS-D-12	Provide Notice of Violation to Vehicles	The Dynamic Low Emissions Zone System needs to provide individual vehicles notice of a violation. This notification may be sent as a message to in-vehicle systems or sent to roadway signage.
DLEZS-D-13	Notify Enforcement Agencies of Violations	The Dynamic Low Emissions Zone System needs to notify enforcement agencies of a violation.

Dynamic Low Emissions Zone System | Storage and Archive

ID	TITLE	DESCRIPTION
DLEZS-DA-01	Archive Low Emissions Zone Data	The Dynamic Low Emissions Zone System needs to archive traffic data, environmental data, Low Emissions Zone parameters (e.g., geographic limits, fee structure), and event logs (e.g., time the Low Emissions Zone was implemented, time it was decommissioned, etc.).
DLEZS-DA-02	Archive Financial Data	The Dynamic Low Emissions Zone System needs to archive all financial data for toll transactions. This should include all operational data, toll pricing data, incentives, as well as violations. This capability allows the Dynamic Low Emissions Zone System to keep records of all toll transactions.
DLEZS-DA-03	Determine Performance Measures	The Dynamic Low Emissions Zone System needs to determine performance measures and make them available to the operator. A list of potential performance measures is included in Section 9 of the ConOps. These performance measures will be used to monitor the performance of the system.



In-Vehicle System

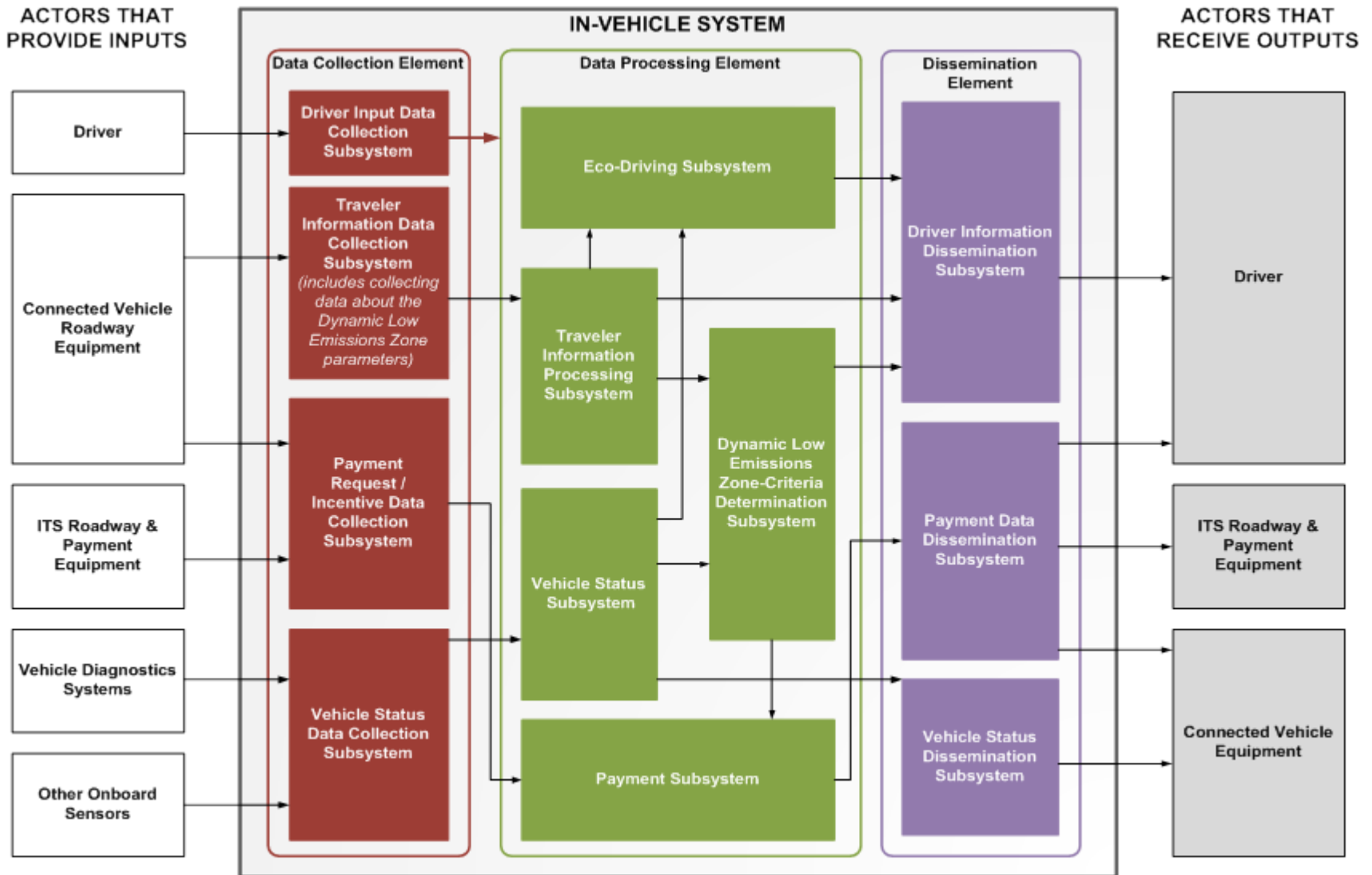


Notes:

- 1 The Driver represents the human entity that operates a licensed vehicle on the roadway.
- 2 Connected Vehicle Roadway Equipment include roadside equipment that transmit or receive data using dedicated short range communications (DSRC) radios or other wireless communications. Connected Vehicle Roadway Equipment provide data to centers (e.g., Traffic Management Centers, Emissions Management Centers) and to vehicle systems.
- 3 ITS Roadway & Payment Equipment include roadway traffic sensors, environmental sensor stations, closed circuit television (CCTV) cameras, and other ITS equipment. This actor also includes roadway components for collection of tolls.
- 4 Vehicle Diagnostic Systems represent computer based systems, located on vehicles, designed to monitor the performance of some of the engine's major components.
- 5 Other On-board Sensors include sensors that may be installed on vehicles to collect traffic or environmental data. Sensors may be added to vehicles to measure atmospheric or surface conditions.



In-Vehicle System *(cont'd)*



In-Vehicle System | Data Collection Needs

ID	TITLE	DESCRIPTION
IVS-DC-01	Collect Driver Input	The In-Vehicle System needs to collect data from the driver to activate applications. The driver also needs to be able to configure parameters of the system or override certain vehicle characteristics.
IVS-DC-02	Receive Traffic Conditions Data	The In-Vehicle System needs to receive traffic conditions data. These data should include information that would typically be displayed on a dynamic message sign (e.g., information about current traffic conditions, incidents, construction, and posted speed limits, and transit options).
IVS-DC-03	Receive Environmental Conditions Data	The In-Vehicle System needs to receive environmental conditions data. These data may include real-time and predicted environmental and air quality conditions that would typically be displayed on a dynamic message sign (e.g., code red day alerts).
IVS-DC-04	Receive Dynamic Low Emissions Zone Parameter Data	The In-Vehicle System needs to receive parameters about Dynamic Low Emissions Zones that have been created and decommissioned. This information should include parameters to ensure that drivers receive necessary information about the Low Emissions Zone, including the location of the Low Emissions Zone, fee structure, and other relevant parameters about the Low Emissions Zone.
IVS-DC-05	Receive Payment or Incentive Request Information	The In-Vehicle System needs to receive requests for payment. These requests may be provided to vehicles using connected vehicle technologies (e.g., DRSC messages) or other wireless technologies including short range communications at electronic toll collection plazas. This capability allows the vehicle system to receive information it will need to pay a fee to enter the Low Emissions Zone.

In-Vehicle System | Data Collection Needs

ID	TITLE	DESCRIPTION
IVS-DC-06	Receive Confirmation of Payment or Incentive	The In-Vehicle System needs to receive confirmation of payment or incentive. This confirmation of payment allows the Dynamic Low Emissions Zone System to inform a driver that their payment was received.
IVS-DC-07	Receive Notice of Violation	The In-Vehicle System needs to receive a notice of a violation. This notification of a violation allows the Dynamic Low Emissions Zone System to inform a driver that they violated the rules when entering the Low Emissions Zone.
IVS-DC-08	Collect Vehicle Diagnostics Data	The In-Vehicle System needs to collect diagnostics data from onboard systems and onboard sensors located on the vehicle to obtain vehicle status and vehicle emissions data. Vehicle diagnostic data includes data from the controller area network (CAN) bus, GPS, environmental sensors, and other sensors located on the vehicle. This includes data about the vehicle's location, speed, acceleration, trajectory, vehicle type, engine type, fuel consumption, and emissions. All data needs to be time stamped. The diagnostics data may be sent to the Dynamic Low Emissions Zone System as input for determining traffic and environmental conditions for a roadway segment, corridor, or region. These data may also be sent to the Dynamic Low Emissions Zone System as a vehicle enters the zone or leaves a zone in response to a request for payment or a request for incentive or rebate.



In-Vehicle System | Data Processing Needs

ID	TITLE	DESCRIPTION
IVS-DP-01	Process Traffic and Environmental Data for Traveler Information Messages	The In-Vehicle System needs to process traffic and environmental data and develop traveler information messages to be provided to the driver. Traffic data may include information of traffic conditions including travel times, incidents, and construction activities. Environmental data may include information about weather conditions or air quality conditions.
IVS-DP-02	Determine Trip/Route Options	The In-Vehicle System needs to determine trip/route options to present to the driver. These options may include routes that require the vehicle to enter the Dynamic Low Emissions Zone or travel around (or avoid) the Dynamic Low Emissions Zones, or may recommend transit options.
IVS-DP-03	Determine Eco-Driving Recommendations	The In-Vehicle System needs to determine driving recommendations with the objective of promoting a driving style that lowers vehicle emissions. This may include advice about recommended speeds, accelerations, and decelerations based on upcoming traffic conditions, and roadway geometry and potential interactions with nearby vehicles.



In-Vehicle System | Data Processing Needs

ID	TITLE	DESCRIPTION
IVS-DP-04	Determine the Vehicle's Criteria for Entering the Dynamic Low Emissions Zone	The In-Vehicle System needs to determine if the vehicle meets the criteria for entering the Dynamic Low Emissions Zone. Upon receiving parameters for the Dynamic Low Emissions Zone, the In-Vehicle System needs to use vehicle diagnostics data and other data collected from vehicle systems to determine the vehicle's fee for entering the Dynamic Low Emissions Zone.
IVS-DP-05	Determine Vehicle Emissions Data	The In-Vehicle System needs to calculate estimates of tailpipe emissions and fuel consumption if these data cannot be collected directly from the vehicle. These estimates may be based on data collected from sensors located on the vehicle. Information such as the vehicle type, engine type, fuel type, second-by-second speed and acceleration, and accessory use (e.g., use of the AC) may be used to estimate tailpipe emissions and fuel consumption.
IVS-DP-06	Manage Fee Payment	The In-Vehicle System needs to process requests for payment. The In-Vehicle System will send data specific to the vehicle (e.g., engine type, real-time emissions data, and emissions profile for the vehicle) to the Dynamic Low Emission Zone System for fee calculation.



In-Vehicle System | Dissemination Needs

ID	TITLE	DESCRIPTION
IVS-D-01	Provide Traffic Conditions to the Driver	The In-Vehicle System needs to provide traffic conditions to drivers so they can make informed decisions during their trips. These data should include information that would typically be displayed on a dynamic message sign (e.g., information about current traffic conditions, incidents, and posted speed limits).
IVS-D-02	Provide Environmental Conditions to the Driver	The In-Vehicle System needs to provide environmental conditions to the driver so they can make informed decisions during their trip. These data may include real-time and predicted environmental and air quality conditions that would typically be displayed on a dynamic message sign (e.g., code red day alerts).
IVS-D-03	Provide Dynamic Low Emissions Zone Parameters to the Driver	The In-Vehicle System needs to provide Dynamic Low Emissions Zone parameters to the driver. This information should include parameters to ensure that drivers receive necessary information about the Low Emissions Zone, including the location of the Low Emissions Zone, fee structure, and other relevant parameters about the Low Emissions Zone.
IVS-D-04	Provide Trip/Route Information to the Driver	The In-Vehicle System needs to provide trip/route information to drivers including options for the driver to reach their destination. The system needs to provide eco-routing navigation capabilities that find the most eco-friendly route in terms of minimum fuel consumption or emissions between a trip origin and a destination.
IVS-D-05	Provide Eco-Driving Information to the Driver	The In-Vehicle System needs to provide eco-driving information to drivers that encourage them to drive in a more environmentally efficient manner.

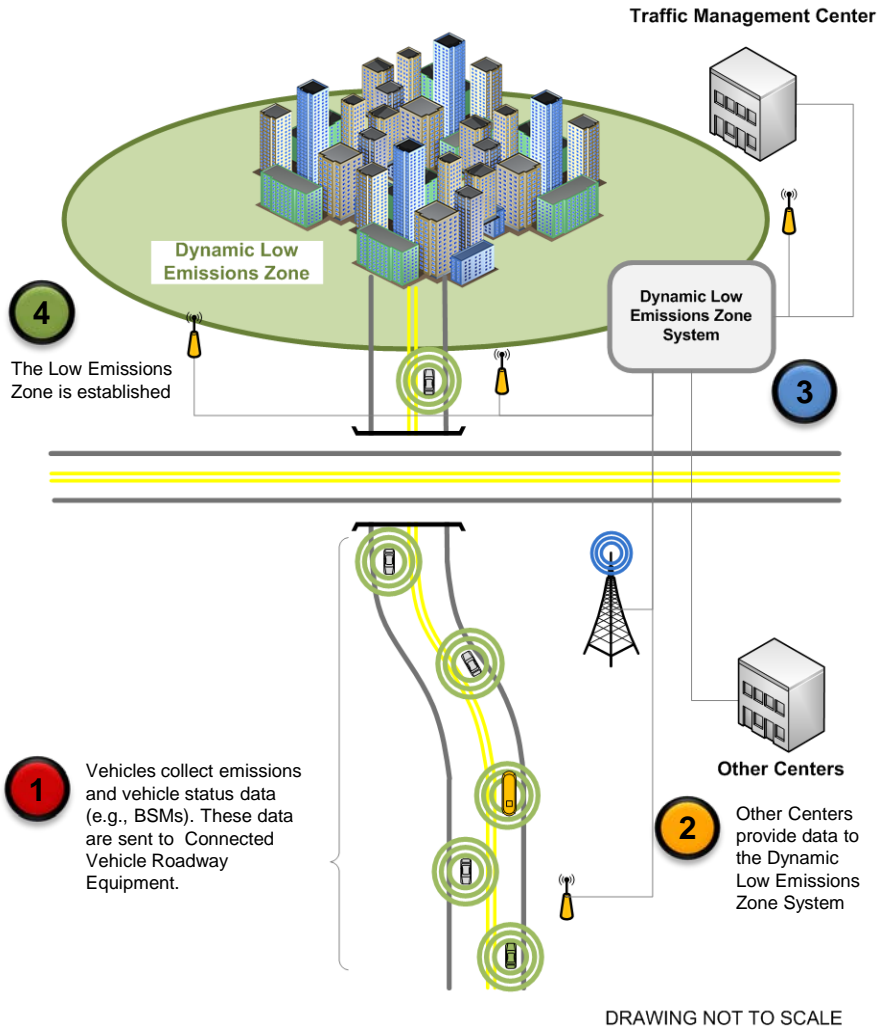
In-Vehicle System | Dissemination Needs

ID	TITLE	DESCRIPTION
IVS-D-06	Disseminate Payment / Incentive Data	The In-Vehicle System needs to provide payment information so that the account associated with the vehicle can be debited for the amount required to enter the Dynamic Low Emissions Zone.
IVS-D-07	Disseminate Vehicle Status Data	The In-Vehicle System needs to transmit vehicle status data or data that is currently included in the SAE J2735 basic safety message (BSM) (e.g., data about the vehicle's location, heading, speed, acceleration, braking status, and size).
IVS-D-08	Disseminate Vehicle Status Environmental Data	The In-Vehicle System needs to broadcast environmental data messages based on data collected from sensors located on-board the vehicle, or data that it processed. The environmental data message includes data such as the vehicle's fuel type, engine type, current emissions, average emissions, current fuel consumption, and average fuel consumption. These data are needed to determine an individual vehicle's fee prior to entering the zone or incentive as the vehicle is leaving the zone. Additionally, this information may be disseminated to the Dynamic Low Emissions Zone System as input for determining when a Low Emissions Zone should be established or decommissioned.



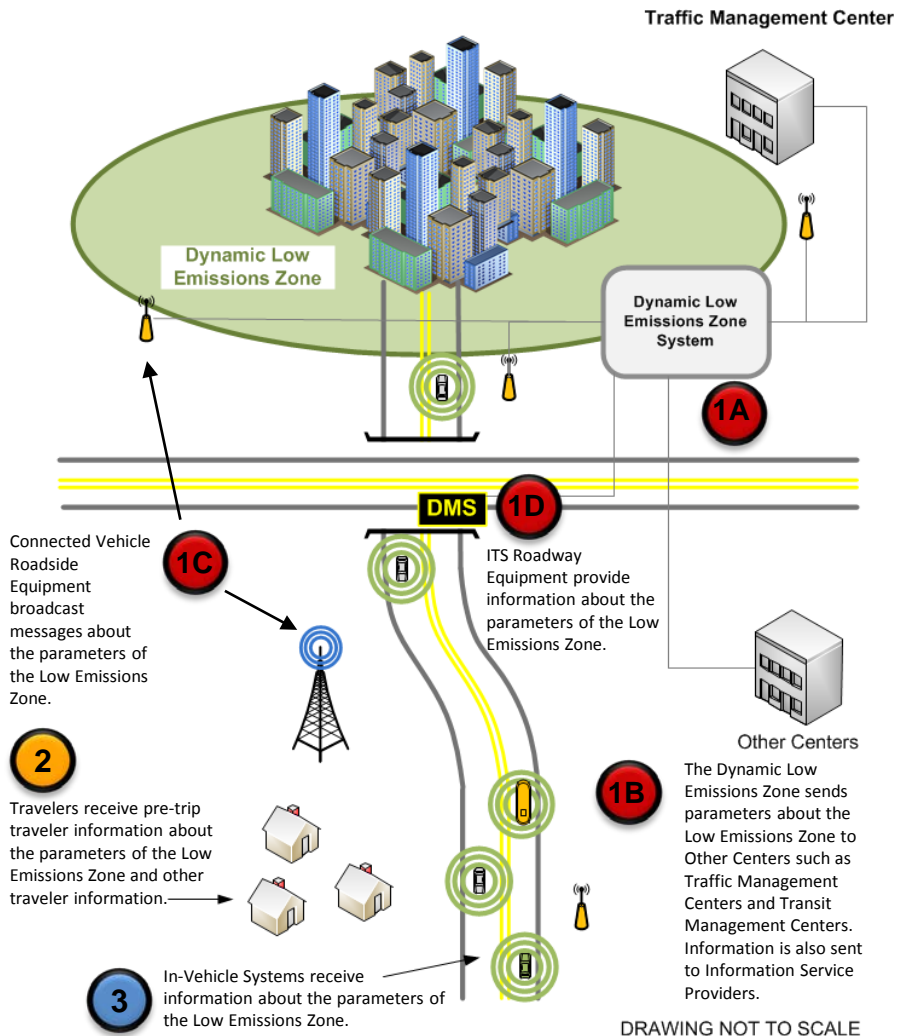
5. SCENARIOS

Dynamic Low Emissions Zone: Establishing a Low Emissions Zone



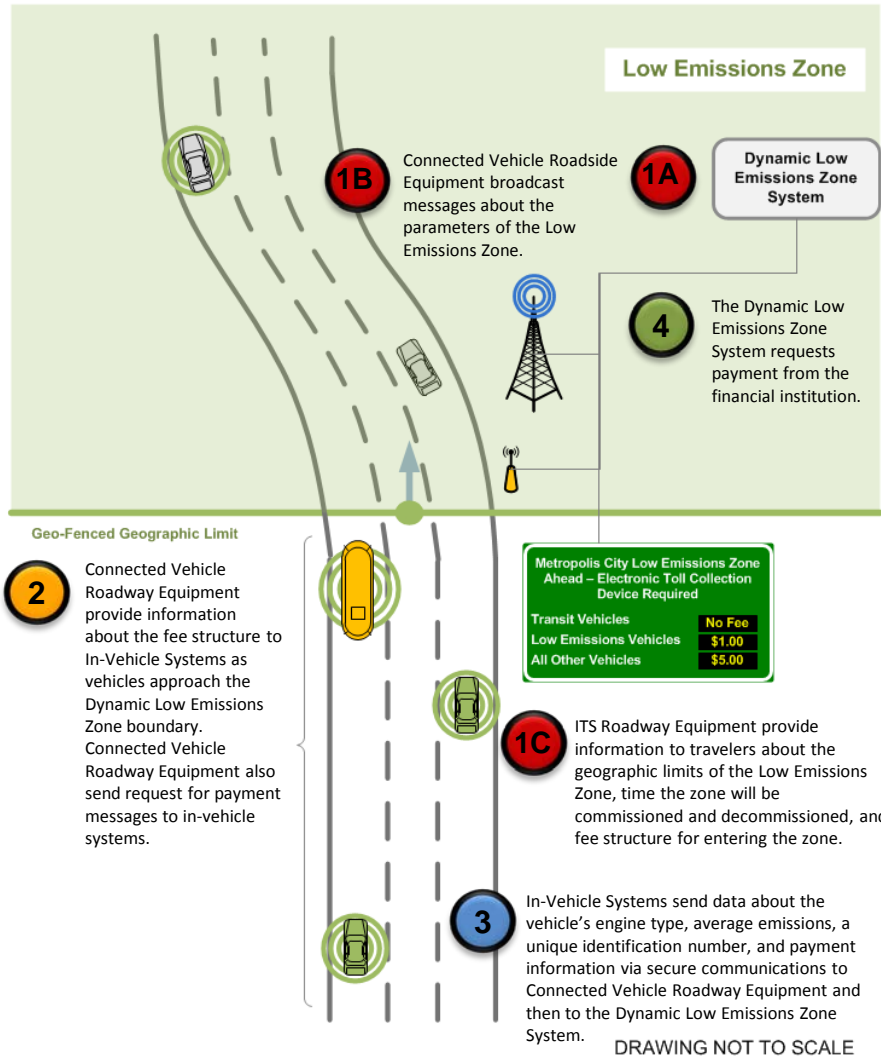
Step	Description
1	In-Vehicle Systems collect data from vehicle diagnostic systems and other onboard systems about the vehicle's emissions and vehicle's status (e.g., current speed, acceleration, location, etc.). These data are sent to Connected Vehicle Roadway Equipment using DSRC, or other wireless communications . Vehicle emissions data may be collected directly from vehicle diagnostic systems or estimated from other data collected from the vehicle. Estimates for emissions may be based on the vehicle's speed, acceleration, and engine characteristics. If emissions data cannot be collected or estimated on the vehicle, vehicle status data (e.g., speed, acceleration, engine type, etc.) may be sent to a Connected Vehicle Roadway Equipment and then to the Dynamic Low Emissions Zone System which would estimate vehicle emissions at a center.
2	Other Centers/systems provide traffic, environmental, special event, and transit data to the Dynamic Low Emissions Zone System . These data are sent from center to center. Traffic data includes volumes, speeds, occupancy, travel times, incidents, or other traffic data collected by a Traffic Management Center. These data may be collected using ITS Roadway Equipment such as traffic sensors, probe vehicles, or other ITS technologies. Environmental data includes air quality data or weather data collected by Emissions Management Centers. Finally, transit data includes information about transit routes, transit schedules, and other transit related information from the Transit Management Center.
3	The Dynamic Low Emissions Zone System uses the data collected from Connected Vehicle Roadway Equipment, ITS Roadway Equipment, and Other Centers as well as historical data to determine whether a Low Emissions Zone should be established, and if so, the parameters of the Low Emissions Zone . These parameters include the geographic limits of the Low Emissions Zone, duration of the zone, and fee structure parameters.
4	The Low Emissions Zone is established by the Dynamic Low Emissions Zone System and is approved by the operator. The Dynamic Low Emissions Zone System geo-fences the geographic limits of the zone and assigns parameters including the fee structure for the zone. Once the zone is established, traffic and environmental data continue to be collected and monitored by the Low Emissions Zone operators to track the performance of the Low Emissions Zone.

Dynamic Low Emissions Zone: Traveler Information



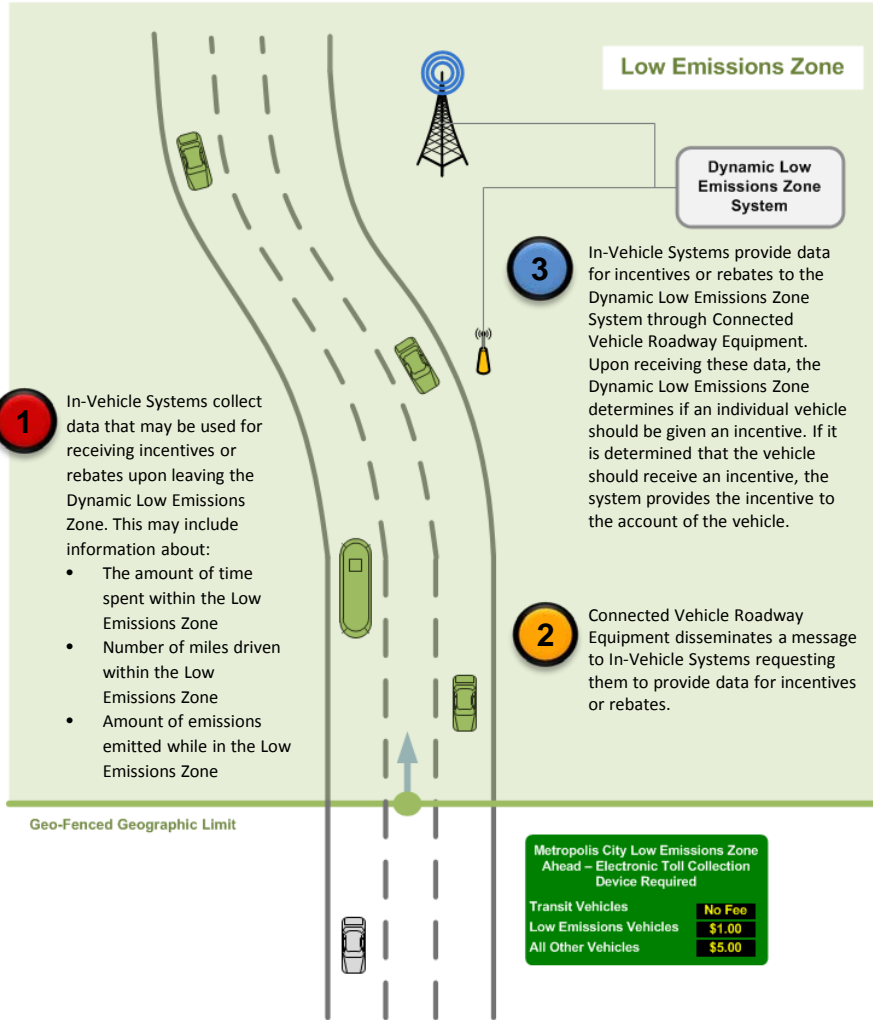
Step	Description
1	<p>Step 1 A The Dynamic Low Emissions Zone System determines the parameters for the Low Emissions Zone.</p> <p>Step 1 B The Dynamic Low Emissions Zone sends parameters about the Low Emissions Zone to Other Centers such as Traffic Management Centers and Transit Management Centers. These centers use information about the Low Emissions Zone to support traffic and transit operations in the vicinity of the Low Emissions Zone. Information is also sent to Information Service Providers, including the media, allowing them to disseminate information to travelers via television, radio, websites, or other sources.</p> <p>Step 1 C Connected Vehicle Roadside Equipment broadcast messages about the parameters of the Low Emissions Zone. Messages may be broadcast using DSRC communications or other wireless communications. This includes information such as the geographic limits of the Low Emissions Zone, the time the zone will be established and decommissioned, and the fee structure for entering the zone.</p> <p>Step 1 D ITS Roadway Equipment including Dynamic Message Signs provide information about the parameters of the Low Emissions Zone.</p>
2	<p>Travelers receive pre-trip traveler information about the parameters of the Low Emissions Zone and other traveler information. This information may be received by travelers from the Low Emissions Zone operating agency or other Information Service Provider on their personal computers, cell phones, tablets, television, radio, or 511 traveler information systems. Travelers use this information to plan their trips accordingly. For example, upon receiving information about the Dynamic Low Emissions Zone, travelers may decide to switch their mode to transit or change their departure time to avoid entering the zone while it is commissioned.</p>
3	<p>In-Vehicle Systems receive information about the parameters of the Low Emissions Zone. This information is presented to drivers to assist them in making informed en-route travel choices as they approach the Low Emissions Zone. Upon receiving this information, drivers may decide to change their route to avoid the Dynamic Low Emissions Zone or decide to switch their travel mode to transit.</p>

Dynamic Low Emissions Zone: Fee Collection



Step	Description
1	<p>Step 1 A The Dynamic Low Emissions Zone System determines the parameters for the Low Emissions Zone.</p> <p>Step 1 B Connected Vehicle Roadside Equipment broadcast messages about the parameters of the Low Emissions Zone. Messages may be broadcast using DSRC communications or other wireless communications. This includes information such as the geographic limits of the Low Emissions Zone, time the zone will be established and decommissioned, and fee structure for entering the zone. This information is received by In-Vehicle Systems.</p> <p>Step 1 C ITS Roadway Equipment provide information to travelers about the geographic limits of the Low Emissions, time the zone will be commissioned and decommissioned, and fee structure for entering the zone.</p>
2	<p>Connected Vehicle Roadway Equipment provide information about the fee structure to In-Vehicle Systems as vehicles approach the Dynamic Low Emissions Zone boundary. Drivers are informed that there is a \$5.00 fee to enter the Low Emissions Zone; however vehicles meeting the low emissions criteria may enter at a reduced fee of \$1.00. Transit Vehicles may enter the Low Emissions Zone at no cost. Connected Vehicle Roadway Equipment also send request for payment messages to in-vehicle systems. These messages request that vehicles provide information about the vehicle's engine type, average emissions, or other vehicle specific data to determine the fee for individual vehicles.</p>
3	<p>In-Vehicle Systems send data about the vehicle's engine type, average emissions, a unique identification number, and payment information via secure communications to Connected Vehicle Roadway Equipment and then to the Dynamic Low Emissions Zone System. Upon receiving this information, the Dynamic Low Emissions Zone System compares these data to the parameters established for the zone and determines the fee for the vehicle.</p>
4	<p>The Dynamic Low Emissions Zone System requests payment from the financial institution. The financial institution transfers funds to the entity operating the Low Emissions Zone.</p>

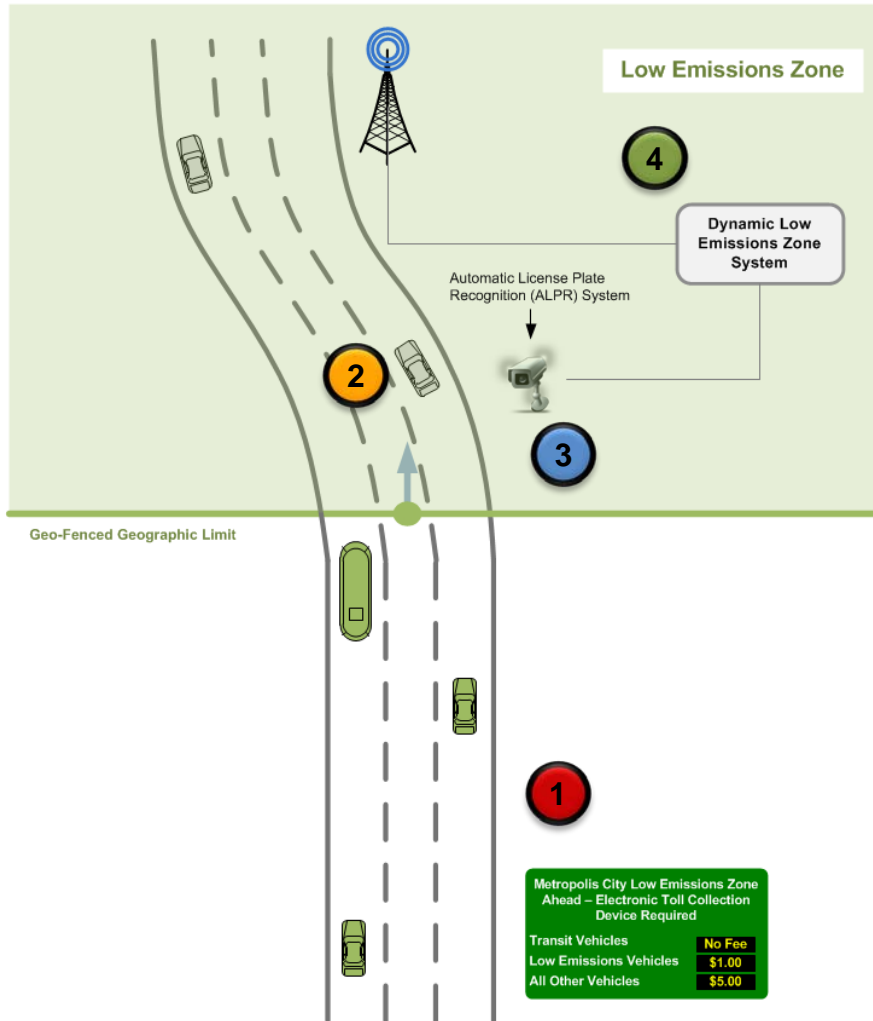
Dynamic Low Emissions Zone: Incentives Leaving the Zone



DRAWING NOT TO SCALE

Step	Description
1	<p>In-Vehicle Systems collect data that may be used for receiving incentives or rebates upon leaving the Dynamic Low Emissions Zone. This may include information about:</p> <ul style="list-style-type: none"> The amount of time spent within the Low Emissions Zone – This would require the Dynamic Low Emissions Zone System to record the time the vehicle entered and exited the Low Emissions Zone. The Dynamic Low Emissions Zone System would calculate the time the vehicle was in the Low Emissions Zone and if it was less than a pre-determined threshold, the driver of the vehicle would be eligible for an incentive or rebate. Number of miles driven within the Low Emissions Zone – This would require the In-Vehicle System to record the number of miles driven within the Dynamic Low Emissions Zone System and provide this information to the Dynamic Low Emissions Zone System. If the vehicle traveled less miles in the zone than a pre-determined threshold, the driver of the vehicle would be eligible for an incentive or rebate. Amount of emissions emitted while in the Low Emissions Zone – This would require the In-Vehicle System to record the number of miles driven within the Dynamic Low Emissions Zone System and provide this information to the Dynamic Low Emissions Zone System. If the vehicle emitted fewer emissions in the zone than a pre-determined threshold, the driver of the vehicle would be eligible for an incentive or rebate.
2	<p>Connected Vehicle Roadway Equipment disseminates a message to In-Vehicle Systems requesting them to provide data for incentives or rebates.</p>
3	<p>In-Vehicle Systems provide data for incentives or rebates to the Dynamic Low Emissions Zone System through Connected Vehicle Roadway Equipment. This information would be sent using secure communications to ensure privacy. Upon receiving these data, the Dynamic Low Emissions Zone determines if an individual vehicle should be given an incentive. If it is determined that the vehicle should receive an incentive, the system provides the incentive to the account of the vehicle. The Dynamic Low Emissions Zone System archives all data related to the incentive request and financial transaction.</p>

Dynamic Low Emissions Zone: Violations



DRAWING NOT TO SCALE

Step	Description
1	The Dynamic Low Emissions Zone requires electronic payment of fees using either Connected Vehicle technologies or a toll tag transponder. A vehicle not equipped with Connected Vehicle technologies, or other means for paying a toll electronically, approaches the Dynamic Low Emissions Zone. Static Signs and messages on DMS prior to the limits of the Dynamic Low Emissions Zone inform the driver about the upcoming zone and requirement for in-vehicle electronic payment systems or transponders. Signage also informs motorists of alternative routes around the Dynamic Low Emissions Zone to avoid entering the zone in violation of the zone's parameters.
2	The driver decides to enter the Low Emissions Zone. Since the vehicle is not equipped with an in-vehicle electronic payment systems or transponder, it is in violation.
3	At the entrance on the Dynamic Low Emissions Zone, an ALPR system takes a picture of every vehicle's license plate. This information is compared to messages collected from vehicles using connected vehicle technologies as they enter the zone and pay their fees. The Dynamic Low Emissions Zone System cannot match the vehicle's information to the payment of a fee and determines it is in violation.
4	Once the Dynamic Low Emissions Zone System determines that a vehicle is a violator, data about the violation and the vehicle (e.g., the vehicle's license plate number) are sent to an Enforcement Agency which issues a citation to the owner of the vehicle. This citation could be given to the vehicle owner by mail, requesting payment for entering the zone.



6. GOALS, OBJECTIVES, AND PERFORMANCE MEASURES

Goals, Objectives, and Performance Measures

Goal #1: Reduce Environmental Impacts	Goal #2: Support “Green Transportation Decisions” by Travelers and Operating Entities	Goal #3: Enhance Mobility of the Transportation System (secondary goal)
<ul style="list-style-type: none"> • Reduce Emissions from Surface Transportation Vehicles <ul style="list-style-type: none"> • Reduce CO₂, CO, NO_x, SO₂, PM₁₀, PM_{2.5}, VOCs • Reduce Energy Consumption Associated with Surface Transportation Vehicles <ul style="list-style-type: none"> • Reduce excess fuel • Reduce energy consumption 	<ul style="list-style-type: none"> • Increase Modal Shifts to Transit, Walking, Bicycling, Carpooling, and Vanpooling <ul style="list-style-type: none"> • Increase non-SOV mode share • Increase transit mode share • Increase active (bicycle/pedestrian) mode share • Increase the number of carpools and vanpools • Increase Usage of Alternative Fuel Vehicles (AFVs) <ul style="list-style-type: none"> • Increase usage of personal, transit, and freight AFVs • Increase Eco-Driving Awareness and Practice <ul style="list-style-type: none"> • Increase the number of drivers practicing eco-driving strategies 	<ul style="list-style-type: none"> • Improve the Efficiency of the Transportation System <ul style="list-style-type: none"> • Reduce the number of person hours (or vehicle hours) of delay • Improve Transit Operating Efficiency <ul style="list-style-type: none"> • Improve average transit travel time compared to auto in major corridors • Maintain or reduce a travel time differential between transit and auto during peak periods • Improve the Efficiency of Freight Operating Efficiency <ul style="list-style-type: none"> • Decrease hours of delay on selected freight-significant routes • Decrease point-to-point travel times on selected freight-significant routes • Increase ratings for customer satisfaction with freight mobility in the region among shippers, receivers, and carriers



Next Steps

- The AERIS Program wants to hear your thoughts on the Dynamic Low Emissions Zones Transformative Concept.
 - You can provide inputs and feedback using the AERIS IdeaScale Site (<https://aeris.ideascale.com>).
 - The AERIS Program will be conducting a Workshop in early 2013 to walk-through the Concept of Operations for the Dynamic Low Emissions Zones Transformative Concept and other AERIS ConOps. More details will be provided as workshop planning is finalized.





AERIS

Contact Information

Marcia Pincus

Program Manager, Environment (AERIS) and ITS Evaluation
USDOT Research and Innovative Technology Administration

marcia.pincus@dot.gov

<http://www.its.dot.gov/aeris/index.htm>