I-95 Corridor Coalition
Truck Parking Initiative

Concept of Operations
Version 4.0

Prepared for:

Federal Highway Administration (FHWA)

Prepared by:

I-95 Corridor Coalition

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1.0 Introduction

This document presents the Concept of Operations (ConOps) for the I-95 Corridor Coalition's *Commercial Truck Parking Location System* (TPLS). It is the first of three technical documents setting the stage for development and deployment of the TPLS. The ConOps provides a high-level, user-oriented view of the planned truck parking system concept. It will be used as a guidebook in the design, development, installation, and testing of the real-world information system.

The ConOps progresses sequentially from information about current truck parking conditions, to user needs, to specification of a top-level TPLS approach to meeting those needs. It identifies and examines the two operational user scenarios under which the system will function. The ConOps concludes with identification of the metrics by which system performance will be assessed.

Figure 1, below, depicts the systems engineering process governing the deployment of the TPLS. As shown in the diagram, the ConOps is an early, first step in the deployment process that sets the stage for all subsequent development activities. Additionally, the ConOps establishes the *de facto* framework against which the emerging system will eventually be validated.

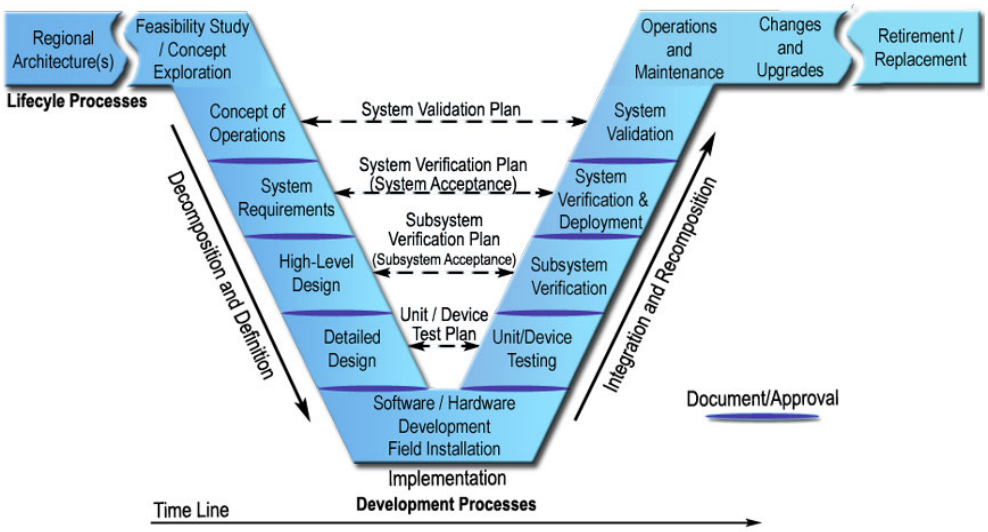

Figure 1: Systems Engineering "V" Diagram
(Source: Systems Engineering for Intelligent Transportation Systems, USDOT, Jan 2007)

The ConOps is the first of three companion, pre-development documents defining the TPLS. The two additional documents cover (1) System Requirements, and (2) System Design.

This document was prepared by the I-95 Corridor Coalition in support of the Federal Highway Administration's (FHWA) Truck Parking Initiative. Telvent Farradyne, under the guidance of the Coalition's Truck Parking Stakeholder Steering Committee, assisted in its preparation.

2.0 Project Background

This section details the project coverage area, provides an overview of the truck parking problem, and introduces the truck parking system concept.

2.1 Coverage

The project area is along a segment of the I-95 corridor extending from Connecticut through North Carolina. The project coverage area and truck parking facilities by type are shown in Figure 2. The project area passes through a number of the nation's most congested urban areas. The eight states comprising the project area are home to 130,000 active commercial motor carriers, or 18 percent of all interstate and hazardous materials carriers nationwide; tens of thousands of additional carriers domiciled outside the region operate in and through these states. Table 1 offers details of the truck parking supply in the corridor.

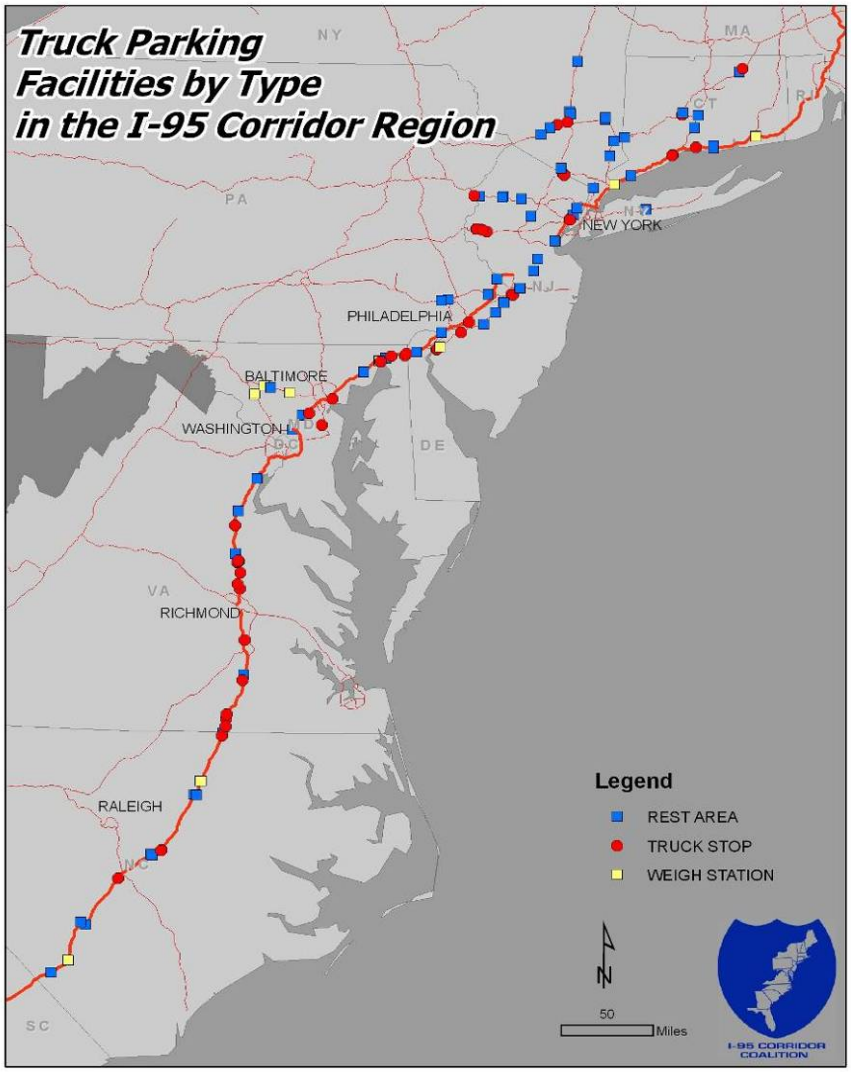

Figure 2: Truck Parking Coverage Area and Facilities by Type

Table 1: Truck Parking Supply*

State	PUBLIC		PRIVATE	TOTAL
	Rest Area/ Service Plaza Spots	Weigh Station Spots	Truck Stop Spots	Total Spots
Connecticut	210	15	700	925
New York	246	0	276	522
New Jersey	834	49	1,679	2,562
Pennsylvania	113	0	60	173
Delaware	40	0	0	40
Maryland	206	168	1,306	1,680
Virginia	242	0	1,542	1,784
North Carolina	122	48	495	665
Study Area	**2,013**	**280**	**6,058**	**8,351**

*Estimated data from state, private, and other miscellaneous sources: 2006-2008

2.2 Truck Parking Problem

Truck parking is a multifaceted problem. It is first and foremost a safety concern, since truckers, during peak periods, often find themselves driving around, searching in vain for available parking spaces, even when their driving times have exceeded the hours-of-service limits. Not able to locate available spaces, truckers sometimes park illegally and unsafely on highway shoulders and ramps.

A big part of the national problem is an inadequate supply of parking spaces for commercial vehicles. However, the underlying premise of this technology effort is that an adequate supply of available spaces frequently exists, but that truckers during key congestion periods – especially late at night when parking lots are crowded – often do not know where to find the available spaces. Consequently, the TPLS will employ optical imaging analytics and traveler information technologies to communicate near real-time information to truckers on the locations of unoccupied truck parking spaces. (Other components of the Coalition's project are examining techniques to expand the supply of truck parking spaces.)

States and Metropolitan Planning Organizations (MPOs), across the study area, have investigated the truck parking problem. For instance, the Maryland Department of Transportation (MDOT) observed more than 250 illegally-parked trucks on average over four nights of observations. The North Jersey Transportation Planning Authority (NJTPA) identified 280 trucks parked on highway shoulders, ramps, and local streets near port terminals and concentrations of warehouses. Throughout Pennsylvania, approximately 1,100 trucks park illegally on a typical night. Each one poses a risk for passing drivers. The projected doubling of truck traffic in the corridor expected by 2030, combined with the current shortfall and lack of information about truck parking options, means that the number of trucks parking illegally on highway shoulders and ramps will increase dramatically in the coming years.

Figure 3 - Trucks Parked Illegally on I-95 in Maryland
(Source: Maryland Department of Transportation)

When the driver of a commercial vehicle makes the decision not to park on the roadway, there is always the factor of wasting time and fuel searching for parking spaces where none are available. Anecdotal evidence collected via truck driver interviews suggests that truckers don't always know that there are available spaces at the next interchange or rest area. Truckers who are unfamiliar with an area may prefer to stay on or very close to a highway (e.g., on a ramp), rather than risk getting lost on local roads. When they see trucks parked on a highway shoulder before a rest area, they may assume the parking area is full even if spaces are available. If they see trucks parked on an exit ramp, they may assume the truck stops at that interchange are full.

The map in Figure 4 shows truck parking capacity and utilization in the corridor. The largest "dots" on the map are the private truck stops located along the corridor, while the smallest "dots" often are either "mom and pop" facilities or public rest areas located on I-95 or highways feeding into major population and economic centers in the corridor.

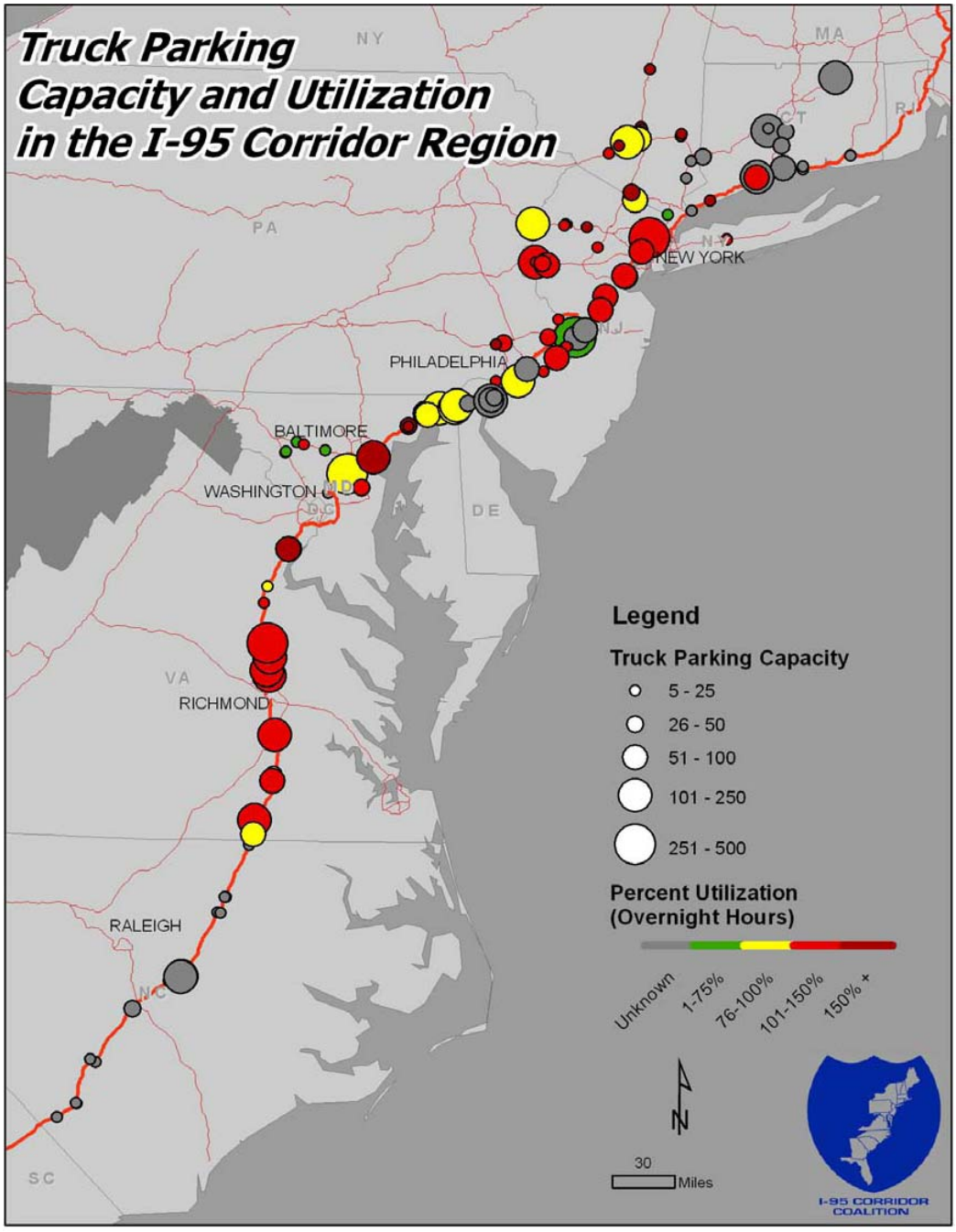

Figure 4: Truck Parking Capacity and Utilization

2.3 Site Selection

The parking areas in which the TPLS will be deployed will be selected based on pertinent site selection criteria and inputs from the partner agencies. During the site selection process, groups of "lot clusters" will be identified. Clusters are lot locations in the general vicinity of one another (e.g., at a given roadway interchange), such that if parking demand exceeds capacity at one lot, it may be accommodated at another nearby lot. A "cluster" may be comprised of 3-6 lots and will be (1) within 3 miles of I-95, (2) within a 25-mile radius of one other, and (3) include a

combination of public rest areas and private truck stops. To the extent that clusters overlap, or are otherwise proximate to one another, they will be called out by the system as potential locations in which a trucker could park. The overlapping clusters will broaden the opportunities for available parking. In addition, the clusters concept will allow truck operators to smoothly and efficiently make last minute changes if an originally planned lot fills prior to arrival.

2.4 Project Goals

Based on the truck parking problem discussion above, the overall goals for the proposed TPLS are to:

- Monitor continuously the availability of commercial vehicle parking spaces across the coverage area;
- Process and compile parking space availability data in real-time; and
- Furnish truckers with accurate, up-to-date parking space availability information efficiently and safely.

3.0 Stakeholders

The stakeholders for this system include both public and private truck parking entities spanning eight states and several jurisdictions. Key stakeholders are identified in Table 2, below.

Table 2 – Truck Parking Location System Stakeholders

State DOTs	
• Connecticut • Delaware • Maryland • New Jersey	• New York • North Carolina • Pennsylvania • Virginia
Authorities	
Maryland Transportation Authority (MdTA)	
New York State Thruway Authority	
New Jersey Turnpike Authority	
Port Authority of New York & New Jersey	
MPOs	
Baltimore Metropolitan Council	
Delaware Valley Regional Planning Council	
Fredericksburg Area Metropolitan Planning Organization	
New York Metro Transportation Council	
North Jersey Transportation Planning Authority	
Richmond Area Metropolitan Planning Organization	
Tri-Cities Area Metropolitan Planning Organization	
Wilmington Area Planning Council	
Associations	
American Trucking Associations	
Commercial Vehicle Safety Alliance	
National Association of Truck Stop Operators	
State Trucking Associations:	
Maryland Motor Truck Association	
Connecticut Motor Carriers Association	
Delaware Motor Transport Association	
New Jersey Motor Truck Association	
New York State Motor Truck Association	
North Carolina Trucking Association	
Pennsylvania Motor Truck Association	
Virginia Trucking Association	
Private Entities	
Private Truck Stop Operators	
Truck Electrification Service Providers	
Trucking Companies	
OOIDA Members	

4.0 Issues and Needs

Truck parking is a problem that spans jurisdictional and public-private boundaries along the I-95 corridor. There is a shortage of truck parking in the corridor, and the shortfall is expected to grow more severe as truck traffic increases. In addition to the capital spending required, the land-use requirements for parking lots and negative public perceptions of trucking have tended to limit expansion of existing lots or the building of new facilities.

Since truck drivers do not presently have access to real-time information on available parking space locations in the corridor, they are often in the position of parking illegally or continuing to drive while fatigued or over the hours-of-service limits. Of course, both responses increase the likelihood of crashes. Many states are reluctant to enforce the parking rules, recognizing that truck drivers must rest when tired, rather than being pressed to continue driving. Also, existing guides and mapping programs are not all-inclusive of available truck parking locations.

4.1 Truck Parking System Needs

Key needs associated with TPLS are identified in Table 3, below.

Table 3 – Truck Parking Location System Needs

ID	Description of Needs
1.	Need to provide reliable, accurate, and near real-time commercial vehicle parking space availability information to truck drivers, transportation organizations, and other stakeholders.
2.	Need to collect parking availability data for publicly- and privately-operated truck parking lots of various layouts, access configurations, sizes, etc.
3.	Need to collect parking availability data continuously.
4.	Need to collect parking availability data under a range of normal and adverse weather and travel conditions.
5.	Need to collect parking availability data under a variety of lighting conditions.
6.	Need to integrate and disseminate parking information in a secure, redundant, and reliable environment.
7.	Need to provide truck parking information continuously.
8.	Need to provide truck parking information both pre-trip and en-route.
9.	Need to disseminate truck parking information to truckers, using conveniently accessible media formats, consistent with USDOT safety policies.
10.	Need to monitor the status and reliability of the truck parking system.

4.2 Truck Parking System Concept

Capacity expansion is integral to solving the truck parking problem. However, with or without capacity expansion, the use of information technologies to furnish information to truckers about truck parking availability is expected to lead to more efficient use of existing parking spaces within the I-95 corridor. With accurate, up-to-date information about the supply and availability of parking throughout the I-95 corridor, truckers will be able to make more informed decisions about where and when to park.

TPLS will inform truckers about the availability of truck parking spaces along a segment of the I-95 corridor extending between Connecticut and North Carolina. It will consist of three major subsystems – (1) a Data-Collection Subsystem, (2) a Data-Integration Subsystem, and (3) a Data-Dissemination/Traveler Information Subsystem. The TPLS will address the truck parking problem by using optical imaging technology to collect and analyze raw vehicle occupancy data in parking facilities within the project area. The data from all outfitted facilities will be integrated via a central database and management system. Real-time parking availability information will then be provided to truckers using two primary methods: (1) a website, and (2) a hands-free, intelligent telephone system with an automated callback feature. Additionally, it is anticipated that at least one truck parking cluster area, supported by operational activities at a state or regional Traffic Management Center (TMC), will demonstrate dissemination of the parking availability information to truckers using highway advisory radio (HAR), dynamic message signs (DMS), or related media.

TPLS will be a stand-alone system, meaning that it will not require interface with other agency or statewide systems to provide parking lot availability information to truckers. However, states and other stakeholders will have the option of providing direct links to TPLS – e.g., through state 511 systems or from customer kiosks at welcome centers and rest areas. A TPLS external data stream containing the parking data will also be made available to external agencies for potential bundling with other traveler information.

5.0 Framework & Approach

Enhanced safety and improved operating efficiencies are key principles guiding the TPLS concept. Providing reliable truck parking information to truckers using state-of-the-art technologies should help to make for better utilization of available truck parking spaces on the I-95 corridor. Reduced instances of trucks parking on ramps and shoulders, or searching under congested conditions for available spaces, should lead to safer roadways. Easier access to parking information should decrease driver frustration and distraction. For the trucking industry, such a system should help mitigate hours-of-service violations, reduce fuel costs, and provide time savings by lessening the time required to locate parking.

The TPLS will use optical imaging/video analytic technologies to collect and analyze data. The guiding principle behind the use of data collection technologies will be reliability, accuracy, and timeliness.

It is essential that the TPLS be capable of providing its important information to truck operators without compromising safety. The over-the-phone system must be designed for hands-free, easy-to-use, voice-activated operation and require minimal set-up. A truck parking website will also be available to truck operators for pre-trip planning.

To help ensure that the resultant TPLS maximizes safety and operational efficiency, the Coalition will work with professional truck operators, human factors specialists, and other industry experts during design of the TPLS intelligent phone and website systems. Towards this end, a TPLS Safety Design Summit is planned early in the project's design phase.

In general, trucking industry support is critical to the success of this system. The Coalition shall, therefore, engage in outreach to the trucking industry, other safety advocates, and FHWA to establish awareness of, and encourage usage of, the system.

As part of outreach to the trucking industry, the Coalition convened a session of America's Road Team Captains in Louisville, KY. America's Road Team is a national public outreach program led by a small group of professional truck drivers who share superior driving skills and superlative safety fitness records. The primary objective of the session was to demonstrate and gather Road Team Captain inputs on the data-dissemination interfaces that will be used to provide truck parking data to truckers – via the website and over-the-phone interfaces. The second objective was to ensure that over-the-road usage of the system minimized driver distraction and optimized safety.

Overall, the Road Team Captains were fully supportive of the Truck Parking project and were comfortable with the demonstrated interfaces. They offered a range of insights and constructive comments.

6.0 Functional Areas

The Commercial Truck Parking Location System shall consist of three major subsystems:

- **Data-Collection Subsystem** – Collects raw vehicle occupancy data in designated truck parking areas.
- **Data-Integration Subsystem** – Integrates and processes vehicle occupancy data collected from all instrumented truck parking areas to calculate parking availability by area.
- **Data-Dissemination/Traveler Information Subsystem** – Disseminates real-time parking availability information to truck operators through several mechanisms and media.

Figure 5, below, shows the high-level components that comprise the three subsystems. Specific details about each of the subsystems in the diagram are provided in the subsequent sections.

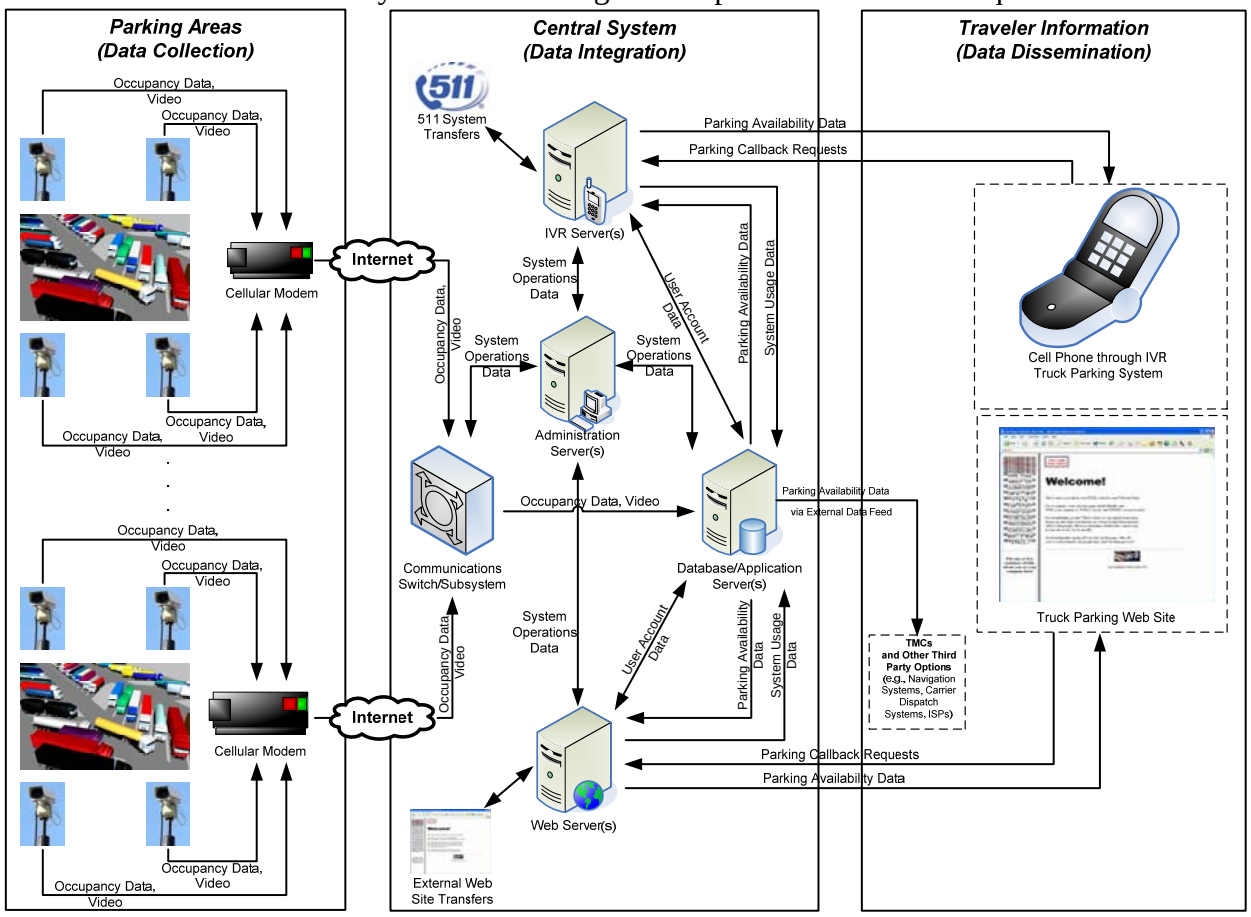

Figure 5: Truck Parking Location System - Context Diagram

6.1 Data-Collection

The TPLS will utilize optical imaging/video analytics technology as the primary component in the collecting of raw vehicle occupancy data in designated truck parking areas. This technology was identified by the Coalition to be a cost-effective way for monitoring parking spaces. Video analytics offers a number of benefits over other competing technologies, such as in-ground sensors, vehicle entry/exit counters, etc. Some of these benefits are listed below:

- Significantly lower capital and maintenance costs compared with in-ground sensors due to less field components.
- Improved accuracy compared with entry/exit counters because given the potential number of parking area ingress/egress locations and different vehicle types to be supported, actual vehicle counts can deteriorate over time with entry/exit counters..
- Increased reliability as there are less field components to fail.
- Increased resilience in adverse weather conditions.

Depending on the layout and size of each parking area, one or more fixed video cameras will be strategically located to maximize the number of parking spaces that can be monitored within each camera's field of vision.

As a value-added option, video captured from the individual parking area cameras can be stored through a digital video recorder for use as a security monitoring application. The video can be transmitted to a central system, along with the occupancy data, for use by operations personnel, rest area owners, etc. Video can be made available on an as-needed basis, or stream continuously depending on the need and available communications bandwidth.

Video cameras will be mounted on existing structures (e.g., light poles, building structures), where possible, to minimize installation costs; otherwise, poles with sufficient strength and height will be installed to house the camera equipment.

When the system is started, or recovers from a power failure, the processors inside the CCTV (closed-circuit television) unit will perform a boot-up operation. This will clear the internal registers and prepare the system for establishing the proper count. The parameters will be set for the field of view, and the boundaries that denote parking spaces will be established.

Video images will be analyzed inside the camera housing, using specially-designed imaging software. Employing sophisticated algorithms, this software will analyze the video images and determine the actual vehicle occupancy status within each monitored parking space. When the software determines there is a vehicle present, the system will send the data to the central system servers. The CCTV and software will then continuously monitor the parking area for changes in the spaces and relay that information to the system servers.

Each parking space will be configured ahead of time, during system setup, as an individual "detection zone". Once a vehicle has stopped in the "detection zone" after a configurable amount of time (i.e., 30 seconds), the system will issue an internal "alarm" that the space is occupied. Likewise, the alarm will be turned off after a vehicle leaves a detection zone. In real-time, vehicle occupancy for each monitored parking space will be calculated and forwarded to a central system for data integration and subsequent processing.

As an additional feature the software will be able to support video capture. Video captured from the individual parking area cameras will be made available to other applications, such as video surveillance and security monitoring. The video will be transmitted to a central system, along with the occupancy data, for use by operations personnel for system monitoring purposes. Video can be made available on an as-needed basis, or streamed continuously depending on the need and available communications bandwidth.

Many of the parking areas in the I-95 corridor have free-form access which makes entry/exit vehicle counting difficult for data collection; this is why optical imaging technology is being used to monitor individual parking spaces in this environment. In situations where access to the parking area is limited, vehicle counting may be performed at exit/entry points only. An assessment of each selected parking area will be conducted to determine the appropriate data-collection technology(ies) to be implemented on a case-by-case basis.

6.2 Data-Integration

The Data-Integration Subsystem will be responsible for key data-integration and processing functions. Primary capabilities include retrieving raw occupancy data from each monitored truck parking area, calculating parking availability by area, and forwarding the parking availability data to dissemination outlets.

Because the system must function in a 24x7 environment, redundant and secure system components will be employed to minimize service disruptions. This will include the use of "hot" standby hardware and associated software that can automatically resume operations in the event of a primary server failure, firewalls to prevent system incursions, backup power, and redundant communications paths between data-collection components and data-dissemination elements.

This subsystem will include software and hardware at a central location to provide the following functionality:

- **Communications** – The communications application will be capable of communicating with data-collection devices of different types and models. It will support communications protocols appropriate for the particular parking space monitoring device(s). It will collect raw parking space count data and video and provide it to the TPLS server application for further processing. As the system grows, the load can be spread among several device drivers, each handling one or more device types.
- **Database Management/Application Processing** – This server will receive and process the raw parking space availability counts from the communications device driver. After receiving the raw data, it will validate, filter and smooth it and subsequently store the raw data in a database for later retrieval and analysis. Histories of the parking lot availability data by site will be maintained in the database. Video will also be captured, if applicable.
- **Interactive Voice Response (IVR) Telephone System Data Feed** – The data feed from the server application to the IVR telephone system will provide updates for the parking areas included in the system.

- **Website Data Feed** – Similar in nature to the IVR telephone system feed, the data feed to the public website will provide available parking space information for use on the TPLS website.
- **External Agency Data Feed –** This external system data feed will provide parking space inventory and available parking space count information in a data stream for use by authorized users. An applicable data standard will be selected for use in defining the data format of this feed. Access to this feed and limitations on the use of the data provided may apply.
- **Overall Management/Operations** – Functionality will be provided to support management and administration of the full system. These TPLS functions will include:
    - Monitoring the general health of the system (e.g., to ensure that data flows between system components are operating properly).
    - Notification and reporting of system alarms/failures.
    - Data archiving and reporting/querying capabilities (e.g., to monitor trends in parking area utilization).
    - Adjusting system configuration parameters (e.g., to modify frequencies in receiving raw occupancy data and disseminating parking availability data to external systems, or to modify the configuration of detection zones for data collection).
    - Restoring and backing up the system.
    - Monitoring video of instrumented parking areas.
    - Logging of system activities for auditing and troubleshooting.

6.3 Data-Dissemination

The TPLS will be capable of providing near real-time truck parking availability information via a range of mechanisms and media in order to ensure that the information is available to as many truckers as possible. The primary methods include:

- **Hands-Free, Intelligent Telephone System** – Automated parking availability information will be provided through an interactive voice response (IVR) system with easy-to-use prompts for identifying desired parking locations; an automatic callback system will update truckers on parking space status at the specified lots as the drivers progress through their routes. Since most truck drivers already carry cell phones, this will be a convenient method of accessing parking availability information, both pre-trip and en-route. To minimize driver distraction, the system will emphasize (1) use of the IVR telephone system with a blue-tooth compatible, hands-free phone; and (2) an automatic callback feature that eliminates redialing and repetition of the input data. Using one or more established toll-free phone numbers (e.g., 1-800-TRUCK-PKG), the IVR phone system will provide the caller with the following capabilities:
    - Recognize speech-based and touch-tone user responses (emphasis will be on speech recognition, especially for truckers using cell phones).

- Assist user in selecting desired parking location:
  - Provide list of instrumented parking areas for selection.
  - Search by exit, city, rest area, landmark, etc. to determine desired parking location.
- Provide count (or range) of available parking spaces at desired location and neighboring locations.
- Provide automatic callback to user's phone at a configurable time interval, advising user of up-to-date parking availability at the selected location. Use Caller ID to determine caller's phone number if not blocked; otherwise, prompt for phone number.
- At start of call, provide option to automatically "remember" parking location selected during previous call made by user within configurable timeframe.
- Provide list of basic amenities available at selected parking location.
- Transfer to selected parking location phone number, if available.
- Provide online help information.
- Accept transfer rollover from state 511 systems, in states wishing to implement such functionality.
- Accept and store user feedback information for reporting and analysis.

- **Truck Parking Website** – For pre-trip planning, a dedicated website will be available to enable truck operators to view parking availability information by location. Local and state transportation agencies will also be able to provide linkages to the Truck Parking Website from their agency websites. The website can also be used in an en-route environment through kiosks implemented at travel centers, welcome centers, and rest areas to provide parking availability information for downstream parking locations, as well as other travel and weather information. Through one or more established URL's (e.g., www.truckparking.com), the truck parking website will provide the user with the following capabilities:
  - Assist user in selecting desired parking location:
    - Provide list of instrumented parking areas for selection.
    - Search by exit, city, rest area, landmark, etc. to determine desired parking location.
    - Provide an interactive map identifying instrumented parking locations. The user will be able to pan-and-zoom the map and select from pre-defined map views (e.g., specific region/state).
  - Provide count (or range) of available parking spaces at each parking location.
  - Provide list of basic amenities available at each parking location.
  - Provide contact information (website, phone number) for parking location, if available.

- Provide directions to selected parking location using third-party product (e.g., Google Maps).
- Provide links to related external websites (e.g., transportation agencies, weather, http://www.i95exitguide.com/restareas).
- Provide "alert" capability to display critical information on website home page. Alerts will be managed through a website administration application.
- Provide online help information and list of frequently asked questions (FAQ's).
- Provide contact information (i.e., e-mail address) for users to ask questions.
- Accept and store user feedback information for reporting and analysis.

- **External Data Feed** – A standardized data feed will be established to provide near real-time parking availability data to transportation agencies and other information service providers for display directly from their own websites and other dissemination outlets. Organizations that wish to receive the data will be provided documentation that explains data content and formats, update frequencies, connection methods, etc. Access to the feed and limitations on the use of the data provided may apply.
- **Specialized Dissemination Mechanism** – Using the external data feed, above, the Coalition is potentially interested in identifying a state partner willing and able to demonstrate dissemination of the truck parking availability data using HAR, DMS, or related medium. The Coalition will make the data feed available to the demonstrating state operator at specified intervals, but it will be the responsibility of the operator to broadcast/post the pertinent information. The Coalition will require the state operator to safeguard the integrity of the parking availability information. That is to say, the data presented on HAR, DMS, or related medium will need to be posted quickly enough that the information is always accurate and timely, and can be assessed safely.

7.0 User Scenarios

Three operational scenarios for the TPLS are briefly described in this section:

- Scenario 1 – Parking Information Dissemination through the Website.
- Scenario 2 – Parking Information Dissemination through the Hands-Free Telephone System.
- Scenario 3 – Parking Information Dissemination Using Highway Advisory Radio (HAR).
- Scenario 4 – System Management
- Scenario 5 – Data Archiving

The website and IVR user interfaces were demonstrated at the Louisville User Sessions and the truck drivers were in agreement that the interfaces will fulfill their truck parking information needs.

7.1 Parking Information Dissemination through the Website

Before heading out on the roadway north from Fredericksburg, Virginia, a truck driver accesses the truck parking website either directly or through links from other transportation agency websites. The driver wishes to locate available parking near I-95 in the Baltimore area. On the website, he searches parking lots by exit, city, rest area, landmark, amenities, etc. to determine available parking locations near Baltimore. He is able to use the pre-defined map views to identify potential parking lots. The website provides information on the current number of spaces available at each of the queried locations. The driver can also set up automatic telephone callbacks from the website (see below).

7.2 Parking Information Dissemination through the Hands-Free Telephone System

A truck driver proceeding north on I-95 through Richmond, Virginia, plans to stop overnight in Baltimore, Maryland. She calls a toll-free number and, through voice-activated drill-down menus, is able to query for parking availability in the Baltimore area. The system provides her availability information for a cluster of Baltimore parking lots. The driver chooses the Chesapeake House North rest area as her destination point and sets the "callback" feature at 30-minute intervals. After 30 minutes, she receives an automated callback from the IVR telephone system that advises her as follows: "As of 10:10PM today, at Chesapeake House North, 8-10 parking spaces are available. Total capacity at this lot is 47 spaces. Would you like to retain this parking lot as your destination point?" If the driver responds, "No," the system prompts her to select other parking options, or to modify or cancel the notification. On the initial call, the system automatically takes note of the driver's phone number – in the event that the phone number is blocked, the driver is prompted to "speak in" the requested phone information.

7.3 Parking Information Dissemination Using Highway Advisory Radio (HAR)

This scenario is being examined as a demonstration in one of the eight states participating in the truck parking project. A trucker traveling through the designated state tunes into highway advisory radio and listens to a message on space availability at a cluster of commercial vehicle parking lots. (Alternatively, the information on space availability at a cluster of lots could potentially be displayed on dynamic message signs.)

7.4 System Management

When an operator receives a camera error notification, or identifies a non-functioning camera at a parking lot, he/she will change the status of the parking lot in question as "data currently unavailable" in the central IVR and web system database. Then the operator will run diagnostics to identify the issue, and perform basic troubleshooting steps to get the camera back on-line. If that fails, the operator will then notify the maintenance technician about the issue along with the camera inventory number and location. If required, the maintenance technician will go on-site to repair or replace the camera. After the repair/replacement is completed, the technician will verify the camera is properly configured, and that the camera is able to communicate with the central system and provide accurate data. The operator will then go back to the central database and bring the parking lot back on-line for the users to access data from the IVR and website.

7.5 Data Archiving

All truck parking data collected over the term of this demonstration project will be archived and available in a database for later retrieval and analysis. These data can be used by research organizations, planners, MPOs, etc. for performing on-going trend analyses, generating parking lot usage reports, and as inputs to predictive algorithms to forecast parking usage.

Every 15 minutes, the TPLS will store a range of pertinent data, including total truck parking capacity in parking spaces, average truck parking space availability over the 15-minute period, and a date-and-time stamp identifying the specific quarter-hour interval.

8.0 Performance Measurement

The data collected and archived from the TPLS will be used to conduct a performance evaluation of the system. There will also be an evaluation of the overall impact of the system on the truck parking problem. Table 4, below, shows the performance metrics and their descriptions. Note that these initial performance measures may be revised as the system requirements are developed and the project evolves.

Table 4 - Performance Measures

Performance Measure	Description
System Reliability	The probability that the system, including all hardware, firmware, and software, will satisfactorily perform the task for which it was designed or intended, for a specified time and in a specified environment.[1]
Data Accuracy	The accuracy of the data collected by the system based on comparisons between system data and "ground truth" data.
Data Reliability	The consistency of the data collected by the system over repeated tests under identical conditions.
Data Currency	The total elapsed time between when the actual occupancy of a parking area changes to when the change is reported by the system.
Impact on the Truck Parking Problem	A comparison of the utilization of instrumented parking areas before and after deployment of the system over a similar period of time with similar environmental conditions.

[1] http://www.its.bldrdoc.gov/fs-1037/dir-036/_5273.htm

9.0 National ITS Architecture Compliance

The planned Commercial Truck Parking Location System (TPLS) project is fully compliant with the *Intelligent Transportation System Architecture and Standards*, as mandated by the Federal Highway Administration (23 CFR 940) and supported by the policy of the Federal Transit Administration.

As shown in Figure 6, below, the National ITS Architecture consists of a series of physical subsystems (i.e., the white boxes). In this diagram, the most pertinent subsystem to the TPLS is "Parking Management," shown in the bottom right corner.

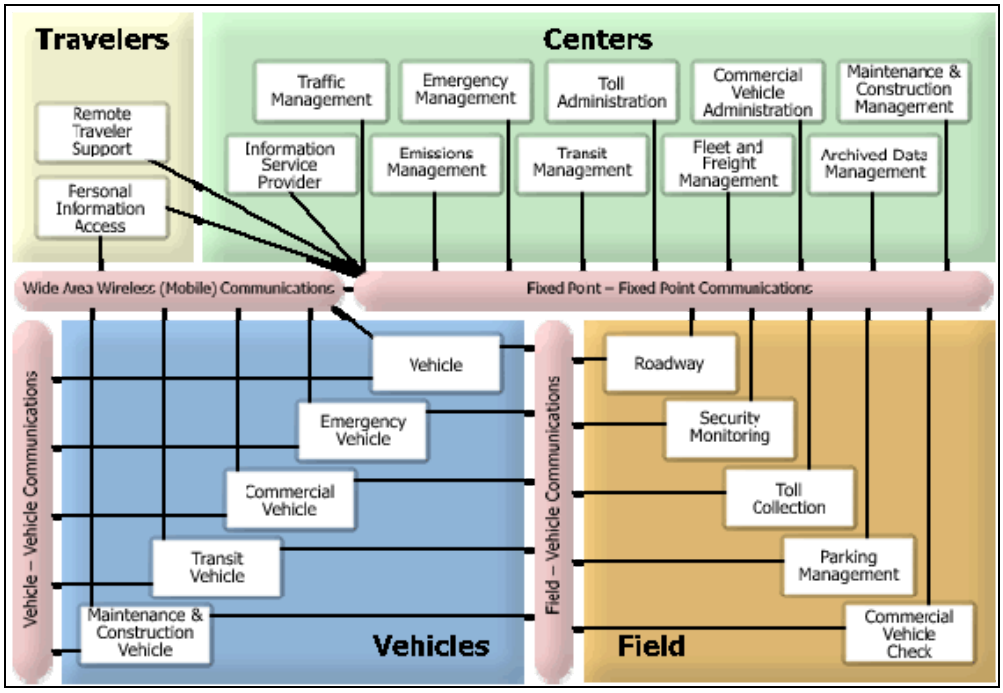

Figure 6: National ITS Architecture

9.1 Description of Elements

Elements are defined as the basic building blocks of an ITS Architecture, and used to describe a system or component of a system. Specifically, Elements are represented in architecture diagrams by the boxes that are exchanging information (through Interconnects and Information Flows). The table, below, describes each element, the associated stakeholders, and their roles and responsibilities in the TPLS project architecture:

Table 5 – ITS Architecture Elements Descriptions

Element Name	Stakeholder	Element Description	Stakeholder Roles and Responsibilities
Archived Data Management Centers	Archived Data Management Agencies: **MPOs –** Baltimore Metropolitan Council, Delaware Valley Regional Planning Council, Fredericksburg Area Metropolitan Planning Organization, New York Metro Transportation Council, North Jersey Transportation Planning Authority, Richmond Area Metropolitan Planning Organization, Tri-Cities Area Metropolitan Planning Organization, Wilmington Area Planning Council	This is a generic element that represents centralized office locations, systems, and personnel for agencies that will collect and archive truck parking data.	• Collect and archive truck parking data from TPLS. • Provide data to state agencies, MPOs, public, etc., for evaluation and future planning purposes.
Commercial Truck Parking Location System (TPLS)	Commercial Truck Parking Location System (TPLS) Stakeholders: **Authorities –** Maryland Transportation Authority (MdTA), New York State Thruway Authority, New Jersey Turnpike Authority, Port Authority of New York & New Jersey **Associations –** American Trucking Associations, Commercial Vehicle Safety Alliance, National Association of Truck Stop Operators, Maryland Motor Truck Association, Connecticut Motor Carriers Association, Delaware Motor Transport Association, New Jersey Motor Truck Association, New York State Motor Truck Association, North Carolina Trucking Association, Pennsylvania Motor Truck Association, Virginia Trucking Association **Private Entities –** Private Truck Stop Operators, Truck Electrification Service Providers	This is a specific element representing the data collection, data integration, and data dissemination subsystems.	• Deploy devices and systems to monitor truck parking space availability. • Disseminate data to stakeholders mostly through the truck parking website and the hands-free phone system. • Provide operations and maintenance support for the TPLS system. • Coordinate with stakeholders to provide project information and outreach.

Element Name	Stakeholder	Element Description	Stakeholder Roles and Responsibilities
Information Service Providers (ISP) Centers	Information Service Providers	This is a generic element representing centers that will collect, process, store, and disseminate transportation information to planners, data archives, truckers, etc.	• Collect information from TPLS using the external feed. • Provide information to planners, truckers, data archives, etc.
Freeway TMC Equipment	State Departments of Transportation: ConnDOT, NYSDOT, NJDOT, MDOT, DelDOT, PennDOT, VDOT, NCDOT	This is a generic element representing equipment distributed on and along the freeways, including highway advisory radio (HAR) and dynamic message signs (DMS) that can be used to disseminate truck parking information to truckers.	• Collect truck parking information from TPLS using the external feed. • Disseminate this information, as appropriate, using HAR, DMS, 511, etc.
Traffic Management Center	State Departments of Transportation: ConnDOT, NYSDOT, NJDOT, MDOT, DelDOT, PennDOT, VDOT, NCDOT	This is a generic element representing state agency facilities that manage a broad range of transportation infrastructure, including freeway systems. These offices/operations centers may provide messages using freeway equipment regarding truck parking availability.	• Collect truck parking information from TPLS using the external feed. • Disseminate this information, as appropriate, using HAR, DMS, 511, etc.
Commercial Vehicles	Trucking Companies: OOIDA Members	This is a generic element representing privately operated freight hauling vehicles generally engaged in interstate commerce. These vehicles include the on-board devices (both permanent and portable) to allow for communications with the TPLS.	• Use the TPLS to find truck parking availability at outfitted lots. • Provide user feedback.

9.2 Equipment Packages

In the National ITS Architecture, the Parking Management Subsystem also consists of a number of equipment packages that represent a set of similar processes grouped together for implementation. The pertinent equipment packages comprising the Parking Management Subsystem used for the TPLS project architecture are as follows:

Parking Coordination – This equipment package supports communication and coordination between equipped parking facilities; it also supports regional coordination between parking facilities and traffic and transit management systems. Information – including current parking availability, system status, and operating strategies – is shared through this equipment package, enabling local parking facility management in support of regional transportation strategies.

Parking Data Collection – This equipment package collects and stores parking information that is collected in the course of parking system operations performed by the Parking Management Subsystem. These data can be used directly by operations personnel or they can be made available to other users and archives in the region.

Parking Management – This equipment package detects and classifies vehicles at parking facility entrances, exits, and other designated locations within the facility. Current parking availability is monitored and used to inform drivers through various dissemination devices so that vehicles are efficiently routed to available spaces. Parking facility information, including current parking rates and directions to entrances and available exits, is also provided to drivers. Coordination with traffic management supports local traffic control activity in and around the parking facility.

9.3 Market Packages

Another way to look at the National ITS Architecture is through the use of market packages, which address specific services. A market package bundles together several different subsystems, equipment packages, and architecture flows that provide the desired service. Below is a list of applicable market packages related to the TPLS.

ATMS 06 - Traffic Information Dissemination – This market package provides driver information using roadway equipment. A wide range of information can be disseminated, including traffic and road conditions, closure and detour information, incident information, and emergency alerts and driver advisories. This package provides information to drivers at specifically-equipped locations on the road network. Careful placement of the roadway equipment provides the information at points in the network where the drivers have recourse and can tailor their routes to account for the new information. This package also covers the equipment and interfaces that provide traffic information from a traffic management center to the media, Transit Management, Emergency Management, and Information Service Providers.

ATMS16 - Parking Facility Management – This market package provides enhanced monitoring and management of parking facilities. It assists in the management of parking operations, coordinates with transportation authorities, and supports electronic collection of parking fees. This market package collects current parking status, shares this data with Information Service Providers and Traffic Management, and collects parking fees using the same in-vehicle equipment utilized for electronic toll collection (or contact or proximity traveler cards used for electronic payment).

ATMS17 - Regional Parking Management – This market package supports coordination between parking facilities to enable regional parking management strategies.

ATIS 01 - Broadcast Traveler Information – This market package collects traffic conditions, advisories, general public transportation, toll and parking information, incident information, roadway maintenance and construction information, air quality and weather information, and broadcasts the information to travelers using technologies such as FM subcarrier, satellite radio, cellular data broadcasts, and Internet webcasts. The information may be provided directly to travelers or furnished to merchants and other traveler service providers so that they can better inform their customers of travel conditions.

ATIS 02 - Interactive Traveler Information – This market package provides tailored information in response to a traveler request. Both real-time interactive request/response systems and information systems that "push" a tailored stream of information to the traveler based on a submitted profile are supported. The traveler can obtain current information regarding traffic conditions, roadway maintenance and construction, transit services, ride share/ride match, parking management, detours, and pricing information. Although the Internet is the predominant medium used for traveler information dissemination, a range of two-way, wide-area wireless and fixed-point to fixed-point communications systems may alternatively be used to support the required data communications between the traveler and Information Service Provider. A variety of interactive devices can be used by the traveler to access information prior to a trip or en–route, including phone via a 511-like portal and web pages via kiosk, personal digital assistant, personal computer, and a variety of in-vehicle devices. Successful deployment of this market package relies on the availability of real-time transportation data from roadway instrumentation, transit, probe vehicles, parking lots, or other means.

ATIS 05 - ISP-Based Trip Planning and Route Guidance – This market package offers the user trip planning and en-route guidance services. It generates a trip plan, including a multimodal route and associated service information (e.g., parking information), based on traveler preferences and constraints. Routes may be generated using static information or reflect real-time network conditions. The trip plan may be confirmed by the traveler. The confirmed trip plan may include specific routing information that can be supplied to the traveler as general directions or as turn-by-turn route guidance depending on the level of user equipment.

9.4 Interconnect Diagram

The TPLS Subsystem interfaces with other elements are as shown in Figure 7, below. These interconnect and information flows diagrams (Figure 8, below) were developed using the National ITS Architecture Turbo Architecture tool.

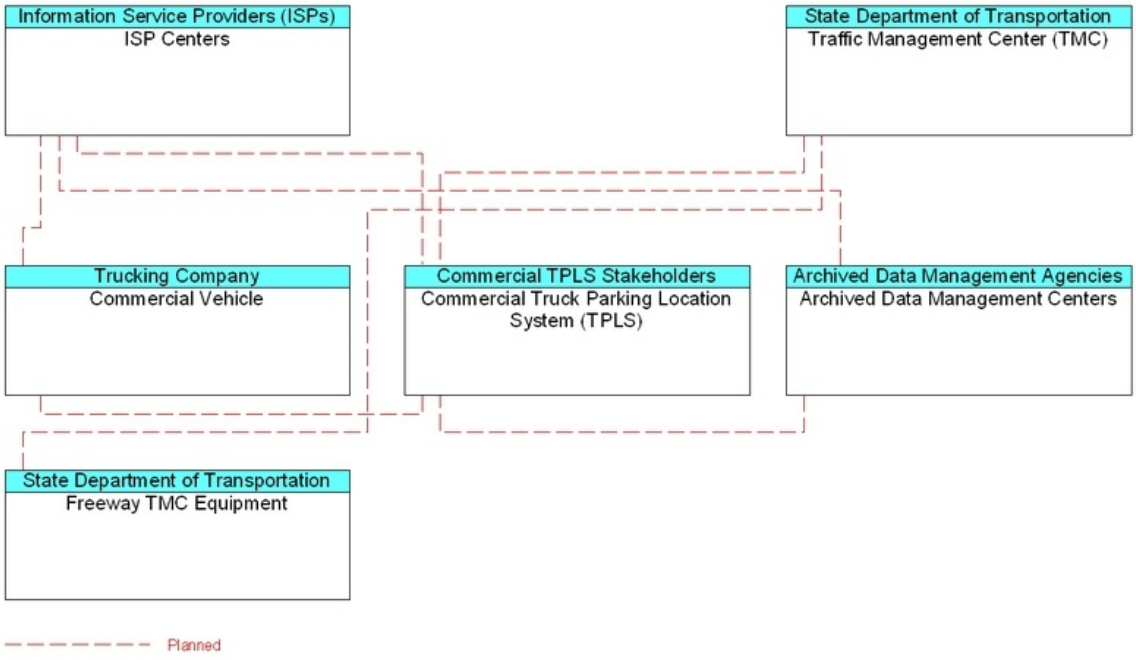

Figure 7 – Truck Parking Location System Interconnects

9.5 Information Flow Diagram

The information flow diagram shown in Figure 8 further defines the information exchanges that constitute every link in the Interconnect Diagram.

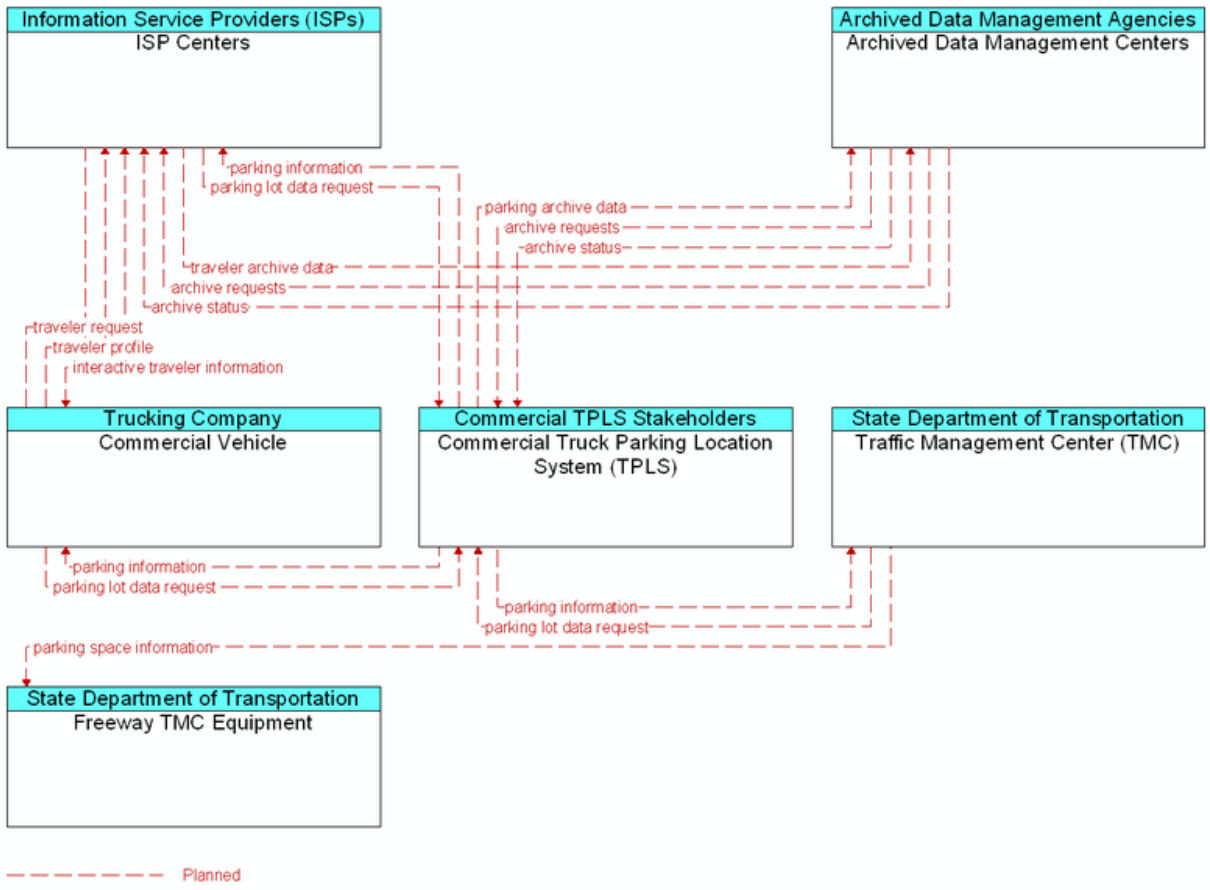

Figure 8 – Truck Parking Location System Information Flows

As shown in Figure 7, parking information is sent to Information Service Providers and the Traffic Management Subsystem. This equates to TPLS functionality to collect parking availability data and distribute aggregated information to the trucking community through specified mechanisms.

Table 6, below, shows the information flows, their descriptions, and the source and destination elements

Table 6 – ITS Architecture Flow Descriptions

Flow Name	Flow Description	Source Element	Destination Element
Archive requests	A request to a data source for information on available data (i.e., "catalog") or a request that defines the data to be archived. The request can be a general subscription intended to initiate a continuous or regular data stream or a specific request intended to initiate a one-time response from the recipient.	Archived Data Management Centers	Commercial Truck Parking Location System (TPLS)
		Archived Data Management Centers	ISP Centers
Archive status	Notification that data provided to an archive contains erroneous, missing, or suspicious	Archived Data Management	Commercial Truck Parking

Flow Name	Flow Description	Source Element	Destination Element
	data or verification that the data provided appears valid. If an error has been detected, the offending data and the nature of the potential problem are identified.	Centers	Location System (TPLS)
		Archived Data Management Centers	ISP Centers
Interactive traveler information	Traveler information provided in response to a traveler request. The provided information includes traffic and road conditions, advisories, incidents, payment information, transit services, parking information, weather information, and other travel-related data updates and confirmations.	ISP Centers	Commercial Vehicles
Parking archive data	Data used to analyze and monitor trends in parking demand, pricing, and operational actions. Content may include a catalog of available information, the actual information to be archived, and associated meta data that describes the archived information.	Commercial Truck Parking Location System (TPLS)	Archived Data Management Centers
Parking information	General parking information and status, including current parking availability.	Commercial Truck Parking Location System (TPLS)	Commercial Vehicle
		Commercial Truck Parking Location System (TPLS)	ISP Centers
		Commercial Truck Parking Location System (TPLS)	Traffic Management Center (TMC)
Parking lot data request	Request for parking lot occupancy, fares, and availability. The request can be a subscription that initiates as-needed information updates as well as a one-time request for information.	Commercial Vehicles	Commercial Truck Parking Location System (TPLS)
		ISP Centers	Commercial Truck Parking Location System (TPLS)
		Traffic Management Center (TMC)	Commercial Truck Parking Location System (TPLS)
Parking space information	This is a user defined flow similar to the “parking information” flow for general parking information and status, including current parking availability.	Traffic Management Center (TMC)	Freeway TMC Equipment
Traveler	Data associated with traveler information	ISP Centers	Archived Data

Flow Name	Flow Description	Source Element	Destination Element
archive data	services including service requests, facility usage, rideshare, routing, and traveler payment transaction data. Content may include a catalog of available information, the actual information to be archived and associated meta data that describes the archived information.		Management Centers
Traveler profile	Information about a traveler including equipment capabilities, personal preferences, and traveler alert subscriptions.	Commercial Vehicles	ISP Centers
Traveler request	A request for traveler information including traffic, transit, toll, parking, road weather conditions, event, and passenger rail information. The request identifies the type of information, the area of interest, parameters that are used to prioritize or filter the returned information, and sorting preferences.	Commercial Vehicles	ISP Centers

9.6 Regional ITS Architectures

The Coalition will work with the appropriate parties to demonstrate conformity of the TPLS project to the regional ITS architecture for the location selected to deploy the system using HAR or similar medium.

10.0 Standards and Acronyms

10.1 Standards

The following potential standards will be adhered to as appropriate:

- Traffic Management Data Dictionary (TMDD) – ITS data standard.
- SAE J2354 – Message Set for Advanced Traveler Information System (ATIS) – Data feed standard.
- Extensible Markup Language (XML) – Data feed standard.
- Hypertext Markup Language (HTML) – Website development.
- Website compliance with Section 508 of the Rehabilitation Act.
- VoiceXML – IVR telephone system development.
- Structured Query Language (SQL) – Database development.

10.2 List of Acronyms

ADMS – Archived Data Management System
CCTV – Closed-Circuit Television
ConOps – Concept of Operations
FHWA – Federal Highway Administration
GPS – Global Positioning System
ISP – Information Service Provider
ITS – Intelligent Transportation Systems
IVR – Interactive Voice Response
MDOT – Maryland Department of Transportation
MdTA – Maryland Transportation Authority
MPO – Metropolitan Planning Organizations
NJTPA – North Jersey Transportation Planning Authority
PMS – Parking Management System
TMS – Traffic Management System
TPLS – Truck Parking Location System
URL – Uniform Resource Locator
TMDD – Traffic Management Data Dictionary
ATIS – Advanced Traveler Information System
XML – Extensible Markup Language
HTML – Hypertext Markup Language
SQL – Structured Query Language