I-95 Corridor Coalition
Truck Parking Initiative

System Design

Version 1.3

Prepared for:

Federal Highway Administration (FHWA)

Prepared by:

I-95 Corridor Coalition

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REVISION TRACKING

Revision	Description	Author	Reviewer	Date
1.0	Original version (preliminary draft)	David Yohanan, Mark McDermott, Tony Connelly, Russ Elovitz, Rick White	Joel Ticatch, David Yohanan, Imran Inamdar	04/20/10
1.1	Updates throughout document	Mark McDermott, Tony Connelly, Russ Elovitz, Chris Tivoli, Rick White, David Yohanan	David Yohanan, Joel Ticatch	05/26/10
1.2	Updates throughout based on FHWA comments and I-95 Corridor Coalition action plan to address comments	David Yohanan	Sudhakar Nallamothu, Joel Ticatch	11/24/10
1.3	Updates based on change in data collection technology and as-built design changes	Chung-Chi Yao, Russ Elovitz	David Yohanan, Joel Ticatch	03/19/14

1 Introduction

This document presents the System Design for the I-95 Corridor Coalition's *Commercial Truck Parking Location System* (TPLS). It provides a description of the planned system and defines how the system is implemented. It serves as a blueprint defining the different components of the system and how they interact.

This document is the third of three technical documents setting the stage for development, installation, and testing of TPLS. The two additional documents cover (1) Concept of Operations and (2) System Requirements.

As background information, this document briefly discusses the current truck parking problem and the planned system deployment area. A high-level description of the envisioned system is given, followed by the architecture and design of the overall system and underlying components.

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

1.1 System Purpose

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 – especially at the critical nighttime periods when they need parking – often do not know where to find the available spaces. Consequently, TPLS employs in-ground sensors and traveler information technologies to communicate near real-time information to truckers on the locations of unoccupied truck parking spaces.

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.

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 1, below. 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.

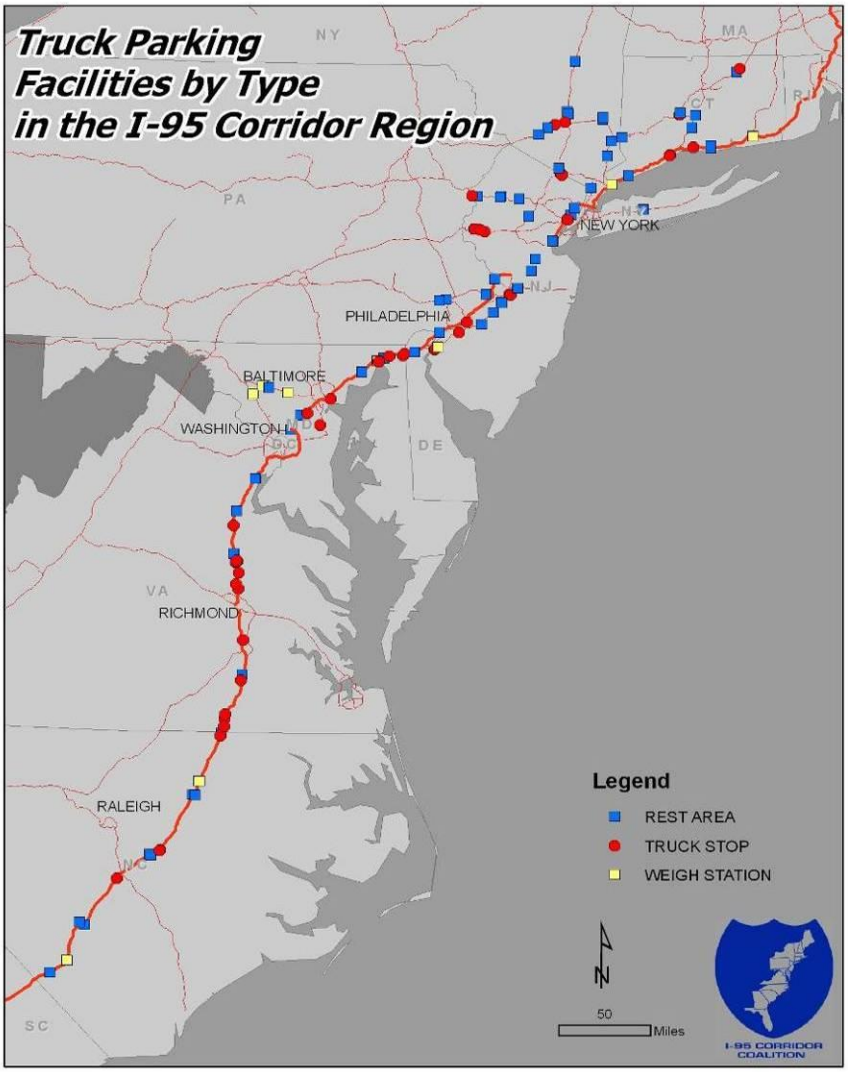


Figure 1. Truck Parking Coverage Area and Facilities by Type

1.2 Tools Used

The tools used to design the Truck Parking Location System components include:

- Telelogic UML Suite – Use Case, Class, Sequence, Deployment and Packaging Diagrams
- Open Office Draw – Component Diagrams
- Microsoft Visio – Data Collection Block Diagrams and IVR Telephone System Call Flow Diagrams
- Altova XMLSpy – Parking Data Export .XSD file design
- Microsoft Office Word 2010 – Preparation of this document

- Microsoft SQL Server Management Studio – Entity-relationship diagrams to describe the database tables

1.3 References

Below is a list of documents containing additional information pertaining to this project:

- *Truck Parking Initiative: Work Plan and Truck Parking Availability System Architecture*, I-95 Corridor Coalition, January 2009.
- *Truck Parking Initiative: Concept of Operations*, I-95 Corridor Coalition, Version 4, November 2010.
- *Truck Parking Initiative: System Requirements*, I-95 Corridor Coalition, Version 1.5, March 2014.
- *Sensys Networks VDS240 Wireless Vehicle Detection System, SNAPS Professional Set Up and Operating Guide*, Version 2.8, October 2012.
- *Sensys Networks VDS240 Wireless Vehicle Detection System, TrafficDOT Set Up and Operating Guide*, Version 2.6, November 2012.

2 General System Description

The *Commercial Truck Parking Location System* (TPLS) informs truckers about the availability of truck parking spaces along a segment of the I-95 corridor extending between Connecticut and North Carolina. It consists of three major subsystems – (1) a Data-Collection Subsystem, (2) a Data-Integration Subsystem, and (3) a Data-Dissemination/Traveler Information Subsystem. TPLS addresses the truck parking problem by using in-ground sensor technology to collect and analyze raw vehicle occupancy data in parking facilities within the project area. The data from all outfitted facilities is integrated via a central database and management system. Real-time parking availability information is then provided to truckers using two methods: (1) a website, and (2) a hands-free, intelligent telephone system with an automated callback feature.

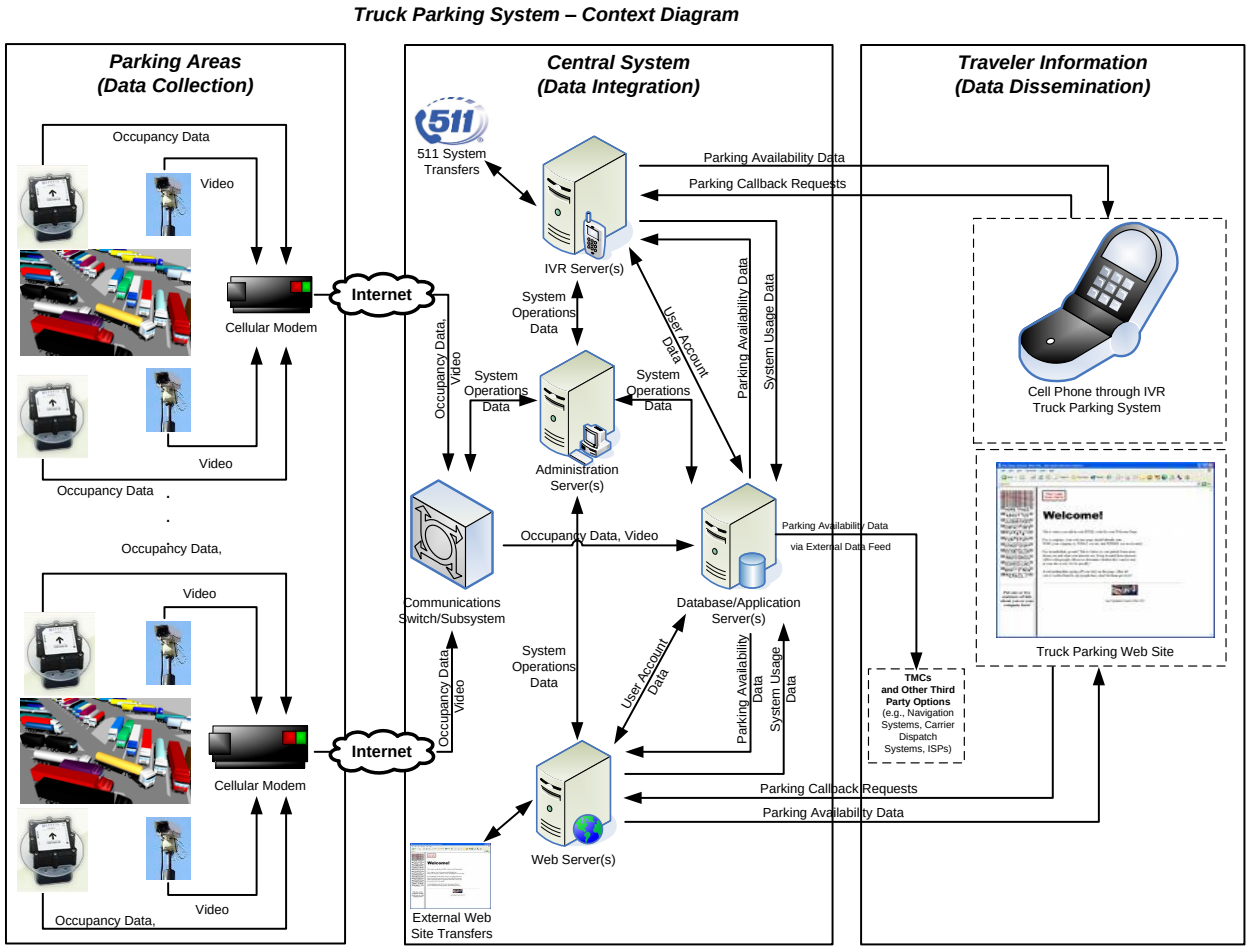


Figure 2. Truck Parking Location System – Context Diagram

As shown in Figure 2 above, the TPLS 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.

Each of these subsystems is described below.

2.1 Data-Collection

The Data-Collection Subsystem utilizes in-ground sensor technology to collect raw vehicle occupancy data in designated truck parking areas. Depending on the layout and size of each parking area, one or more in-ground sensors will be installed in each parking space to check for the existence of a vehicle in real-time.

Detectors will be installed in the ground, and video cameras for additional monitoring will be mounted on existing structures (e.g., light poles, buildings), 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 failure, the status of all detectors will be reset.

Sensor readings will be analyzed inside the detectors, using specially-designed detection software. Employing sophisticated algorithms, this software will analyze the readings 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 sensors 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 (e.g., 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 snapshot capture. Video snapshots captured from the individual parking area cameras will be transmitted to a central system, along with the occupancy data, for use by operations personnel for system monitoring purposes.

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 in-ground sensor technology is being used to monitor individual parking spaces in this environment.

2.2 Data-Integration

The Data-Integration Subsystem is 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.

The use of redundant and secure system components will minimize service disruptions. This includes the use of "hot" standby hardware and associated software that automatically resumes 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 includes software and hardware at a central location to provide the following functions:

- **Communications** – The communications application is capable of communicating with data-collection devices of different types and models. It supports communications protocols appropriate for the particular parking space monitoring device(s). It collects raw parking space count data and video and provides 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 receives and processes the raw parking space availability counts from the communications device driver. After receiving the raw data, it validates, filters, and smoothes the data and subsequently stores them in a database for later retrieval and analysis. Histories of the parking lot availability data by site are maintained in the database.
- **Interactive Voice Response (IVR) Telephone System Data Feed** – The data feed from the server application to the IVR telephone system provides 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 provides available parking space information for use on the Truck Parking Location website.
- **External Agency Data Feed –** This external system data feed provides parking space inventory and available parking space count information in a data stream for use by authorized users. An applicable data standard was 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** – Functions are provided to support management and administration of the full system. These TPLS functions 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.

2.3 Data-Dissemination

The Data-Dissemination Subsystem provides 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 Telephone System** – Automated parking availability information is provided through an interactive voice response (IVR) system with easy-to-use prompts for identifying desired parking locations; an automatic callback system updates truckers on parking space status at the specified lots as driver's progress through their routes. Since most truck drivers already carry cell phones, this is a convenient method of accessing parking availability information, both pre-trip and en-route. Emphasis is placed on using the IVR telephone system with a blue-tooth compatible, hands-free phone for safety reasons. Using one or more established toll-free phone numbers (855-TRK-PARK), the IVR phone system provides 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 "parking area" or parking lot name to determine desired parking location, where "parking area" is the name of a geographic area into which parking lots have been clustered.
  - Provide count of available parking spaces at desired location and neighboring locations.
  - Provide automatic callback to user's phone at a configurable timeframe, 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 "remember upon request" the parking location selected on the Truck Parking website or during the previous call made by the user within a configurable timeframe.
  - Provide list of basic amenities available at selected parking location.
  - Transfer to the selected parking location phone number, if available.
  - Provide online help information.
  - Accept optional call transfers 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 is available enabling truck operators to view parking availability information by location. Local and state transportation agencies can 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.trucknpark.com), the truck parking website provides the user with the following capabilities:
  - Assist user in selecting desired parking location:
    - Provide list of instrumented parking areas for selection.
    - Search by "parking area" or amenity to determine desired parking location, where "parking area" is the name of a geographic area into which parking lots have been clustered.
    - Provide an interactive map identifying instrumented parking locations. The user may pan-and-zoom the map and select from pre-defined map views (e.g., specific region/state).
  - Provide count 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 are managed through a website administration application.
  - Provide 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 provides 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 wishing to receive the data are 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 may apply. See Appendix E for a sample message from this feed.

- **Specialized Dissemination Mechanism** – Using the external data feed, above, the Coalition is interested in identifying a state partner willing and able to demonstrate dissemination of the truck parking availability data using highway advisory radio (HAR) or related medium. The Coalition will make the data feed available to the demonstrating

state operator at specified intervals, but it is 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 or related medium will need to be posted quickly enough that the information is always accurate and timely, and can be accessed safely.

3 System Architecture

The physical architecture of the Truck Parking Location System is based on a set of system hardware similar to that of other systems that collect data from field locations, transport the data to a central system, and then manage and use the data for the purposes of the project. The architecture of the overall TPLS is divided into two major categories, central system and field equipment, as discussed below.

3.1 Central System

The networking, communications, and hardware architecture for the TPLS central system is depicted in Figure 3, below.

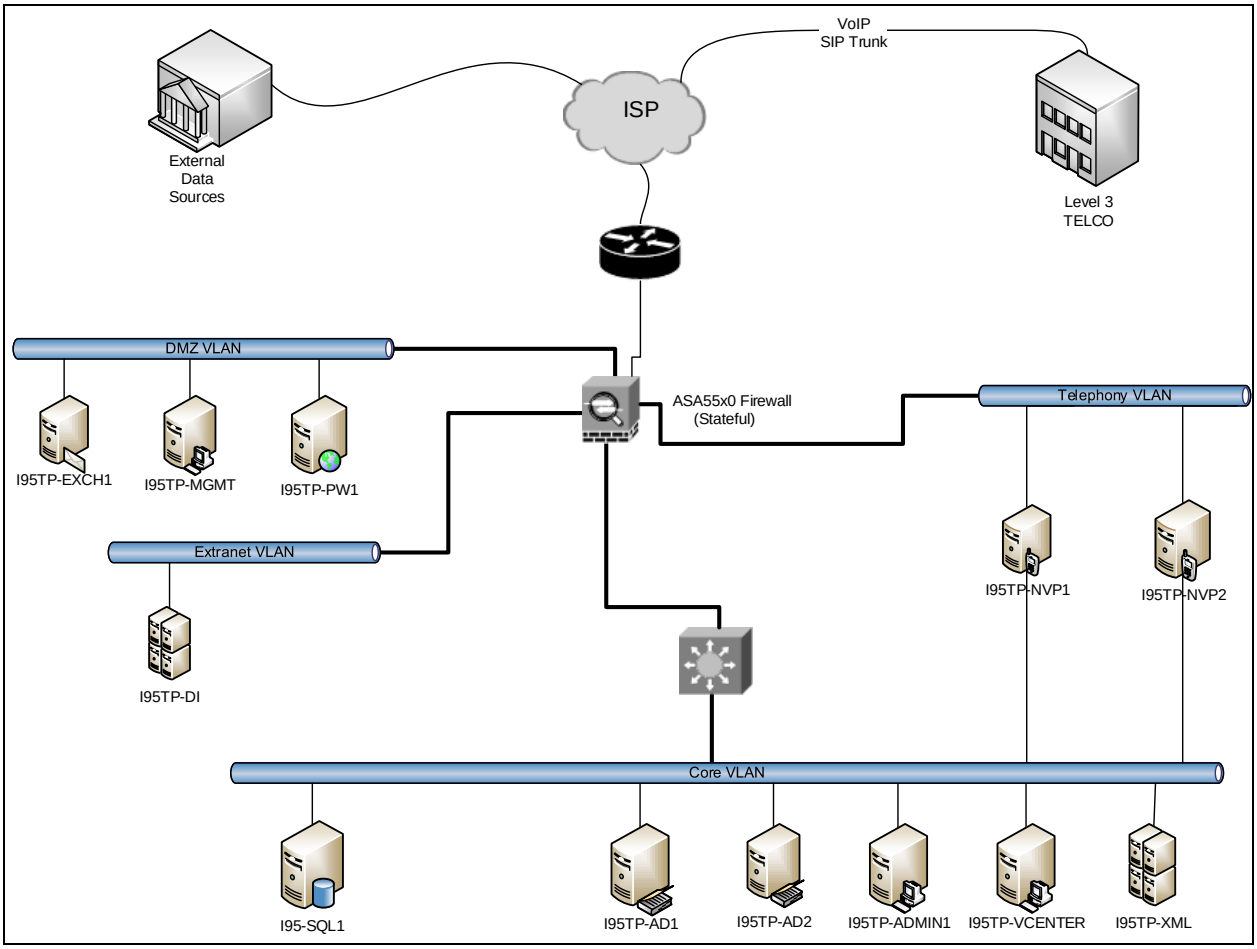


Figure 3. Truck Parking Central System Architecture

Note that both production and pre-production environments will be established. The pre-production environment has a similar configuration to the production environment and is used for system development and testing purposes.

Major components of the central system architecture are as follows:

- External Data Sources – This represents the data interfaces with the in-ground sensors located in the parking areas.

- Internet Service Provider (ISP) – The ISP serves as the communications medium to transmit data and video snapshots from the in-ground sensors and CCTV cameras, respectively, in the parking areas to the central system. This also supports communications of system configuration and status information between the devices and the central system. Communications are handled using the Voice Over IP (VOIP) protocol.

- Telephone Company (Telco) – The Telco (Level 3 Communications) is responsible for providing the toll-free telephone number(s) for the Interactive Voice Response (IVR) system and handling telephone calls between the users and the system.

- I95TP-PW1 (production) / I95TP-PW1-PP (pre-production) – Public Web Servers – These servers provide the public website functionality for the system.

- I95TP-NVP1 (production) / I95TP-NVP2 (production) / I95TP-NVP-PP (pre-production) – IVR Telephony/Conversation Servers – These load-balanced servers provide the telephony functions and the software that allows the caller to interact with the IVR sub-system. These systems are shared between the production and pre-production environments.

- I95TP-DI1 (production) / I95TP-DI-PP (pre-production) – Data Interface Servers – These servers support the exchange of data and video snapshots between the in-ground sensors, CCTV cameras, and various central system components.

- I95TP-XML1 (production) / I95TP-XML-PP (pre-production) – IVR Voice/XML Application Servers – These servers provide the IVR voice application logic and the mechanism to share IVR-related data between the IVR sub-system components and the central database management system.

- I95TP-SQL1 (production) / I95TP-SQL-PP (pre-production) – SQL Servers – These servers house the database management system that stores all the data for the system.

- I95TP-AD1 / I95TP-AD2 – Active Directory Servers – These servers provide Windows directory services and support monitoring the overall health of the system hardware and software. These systems are shared between the production and pre-production environments.

- I95TP-ADMIN1 – Admin Server – This server provides tape backup and network management functionality and supports monitoring the overall health of the system hardware and software. This system is shared between the production and pre-production environments.

- I95TP-EXCH1 – Mail Server – This server provides remote management web services as well as a source for outbound system management email notifications to O&M staff. This system is shared between the production and pre-production environments.

- I95TP-MGMT1 (production) / I95TP-MGMT-PP (pre-production) – Management Server – These servers provide system reporting capabilities for all modules and IVR management functions.

- I95TP-VCENTER – VCenter Server – This server manages the Virtual Machines as well as the High Availability or redundancy of all the servers except for the IVR Telephony/Conversation Servers and the Admin Server. This system is shared between the production and pre-production environments.

- Two VMWare Host Servers – These servers are the base platform where all of the Virtual Machines (VM's) will be located. They are redundant allowing for High Availability for all the Virtual Machines.

3.1.1 COTS Hardware Components

The server hardware for the central Truck Parking System utilizes blade technology comprised of a Dell chassis-based solution for most application servers and Dell stand-alone servers for functions such as connectivity to external peripherals such as a tape backup library. Based on the evaluation of the functional requirements, a total of three server configurations were defined as well as one chassis configuration.

The system architecture provides performance optimization and high availability functionality for critical components through VMWare High Availability and server redundancy, as well as redundant components within each server platform (i.e., redundant power supplies and network interface cards, and RAID1 and RAID5 disk storage for all servers). These methods will be implemented to meet the overall system performance goal of 99% uptime, excluding scheduled maintenance.

3.1.1.1 Server Platforms

The Dell M1000e blade chassis platform is utilized for the majority of the server deployment. The chassis can host up to 16 servers and, in addition to redundant integrated Cisco switch modules, has full redundancy consisting of six power supply modules, nine fan modules, and dual chassis management controllers. The chassis hosts an integrated keyboard-video-mouse (KVM) unit for access to the server consoles and remote management of the chassis via a web-based application as well as any of the server or network switch modules.

A stand-alone server is used for hosting the applications that require additional storage or access to peripherals such as the tape library used for backups. Each server has redundant Ethernet connections to the core switches, redundant power supplies, and a remote access management module allowing remote management of the server.

Table 1, taken from original Dell configuration information, includes the detailed specifications for each of the three server configurations and the chassis configuration designated by type. Information related to the type of server and Commercial Off-the-Shelf (COTS) software allocated for each server in the system is provided in subsequent sections of this document.

Table 1. Hardware Configuration Details

Type	Description
Chassis	Blade Server Enclosure, No Blades, M1000E, PowerEdge (223-3244) Mission Critical Package: 4-Hour 7x24 On-Site Service with Emergency Dispatch, 3 Year Extended (982-1643) ProSupport for IT: 7x24 HW / SW Tech Support and Assistance for Certified IT Staff, 4 Year (982-1833) Mission Critical Package: 4-Hour 7x24 On-Site Service with Emergency Dispatch, Initial Year (985-3800) MISSION CRITICAL PACKAGE: Enhanced Services, 4 Year (989-0659) Dell Hardware Limited Warranty Plus On Site Service Extended Year(s) (989-0728) Dell Hardware Limited Warranty Plus On Site Service Initial Year (989-0747) Thank you choosing Dell ProSupport. For tech support, visit http://support.dell.com/ProSupport or call 1-800-945-33 (989-3439) On-Site Installation Declined (900-9997) Redundant Power Supplies (6x2360W), High Efficiency M1000E Blade Chassis (430-2623) Redundant Chassis Management Controller, PowerEdge M1000E (311-7787) FLEX ADDRESS ENABLED (341-7140) No Operating System Media Kit (420-1908) Dell OpenManage CD Kit for PowerEdge M1000E Blade Server Chassis (310-9694) Dell Management Console (330-5280) Users Guide, PowerEdge M-Series Blades (330-4117) Redundant Ethernet Switch Configuration (311-8060) No I/O Modules, (I/O Bay Filler Panels, Qty 2) M1000E Blade Server Chassis (310-9711) No I/O Modules, (I/O Bay Filler Panels, Qty 2) M1000E Blade Server Chassis (310-9711) Rack Chassis w/Rapid Rails for Dell, HPQ or other Square HoleRacks (310-9689) Avocent Integrated KVM Analog Switch Module, PowerEdge M1000E Chassis (430-2628) Power Cords, QTY3, 2FT C19/C20 for M1000E Server Blade Chassis (330-0146) - Quantity 2 PDU,24A,208V,(4)C19,0U/1U,with L6-30P 3.7m attached input cord (330-6418) - Quantity 2 Blade Blanking Panel for PowerEdge M1000E Blade Server Chassis (310-9709) - Quantity 16 Users Guide, Cisco Catalyst Ethernet Switch for PE M1000E Blade Chassis (430-2851) Cisco 3032, GE, Entry Switch, No Stacking,Redundant (223-5346) Mission Critical Package: 4-Hour 7x24 On-Site Service with Emergency Dispatch, 3 Year Extended (983-3313) ProSupport for IT: 7x24 HW / SW Tech Support and Assistance for Certified IT Staff, 4 Year (983-3503) Mission Critical Package: 4-Hour 7x24 On-Site Service with Emergency Dispatch, Initial Year (986-5580) Thank you choosing Dell ProSupport. For tech support, visit http://support.dell.com/ProSupport or call 1-800-945-33 (989-3439)

Type	Description
	Dell Hardware Warranty Extended Year(s) (989-6058) Dell Hardware Warranty Initial Year (989-6067) MISSION CRITICAL PACKAGE: Enhanced Services, 4 Year (989-6329) On-Site Installation Declined (950-8997)
Server Type 1	PowerEdge M710 Blade Server (224-4901) Shipping Material, Individual Blade, PowerEdge M710 (330-3589) Dell OpenManage Kit for PowerEdge M710 Blade Server (330-3588) Users Guide, PowerEdge M-Series Blades (330-4117) Dell Management Console (330-5280) 96GB Memory (6x16GB), 1333MHz Dual Ranked RDIMMs for 2 Processors, Optimized (317-0236) Server DIMM Slot Blank, Quantity 12 (317-0027) X5560 Xeon Processor, 2.8GHz 8M Cache, Turbo, HT, 1333MHz Max Mem (317-1202) X5560 Xeon Processor, 2.8GHz 8M Cache,Turbo, HT, 1333MHz Max Mem (317-1214) Processor Heatsink, One Required per Processor (317-0362) Processor Heatsink, One Required per Processor (317-0362) 1000GB 7.2K RPM Serial-Attach SCSI 2.5 inch Hot Plug Hard Drive (341-9158) Windows Server 2008SP2 Standard x64, Incl Hyper-V Incl 5 CALs (421-1084) Onboard Broadcom 5709 Quad Port 1GbE NIC, with TOE (430-3553) 1000GB 7.2K RPM Serial-Attach SCSI 2.5 inch Hot Plug Hard Drive (341-9158) Windows ServerR2 2008 Standard Edition, 32 bit and 64 bit Media Kit (421-1094) Add-in PERC6/i with battery supporting 3-4 HDs SAS or SSD-RAID 5 (341-9588) PERC 6/I RAID Controller Card 256MB Cache, w/ Battery M-Series Blade Servers (341-9586) Basic: Business Hours (5X10) Next Business Day On Site Hardware Warranty Repair 3 Year Extended (989-2783) Basic: Business Hours (5X10) Next Business Day On Site Hardware Warranty Repair Initial Year (992-9180) Dell Hardware Limited Warranty Extended Year (993-6998) Dell Hardware Limited Warranty Plus On Site Service Initial Year (993-6987) DECLINED CRITICAL BUSINESS SERVER OR STORAGE SOFTWARE SUPPORT PACKAGE-CALL YOUR DELL SALESREP IF UPGRADE NEEDED (993-6959) Basic support covers SATA Hard Drive for 1 year only regardless of support duration on the system (994-4019) On-Site Installation Declined (900-9997) 1000GB 7.2K RPM Serial-Attach SCSI 2.5 inch Hot Plug Hard Drive (341-9158) 1000GB 7.2K RPM Serial-Attach SCSI 2.5 inch Hot Plug Hard Drive (341-9158)
Server Type 2	PowerEdge M610 Blade Server (224-4894) Shipping Material, Individual Blade, PowerEdge M610 (330-3577) Dell OpenManage Kit for PowerEdge M610 Blade Server (330-3576) Users Guide, PowerEdge M-Series Blades (330-4117) Dell Management Console (330-5280) 24GB Memory (6x4GB), 1333MHz Dual Ranked RDIMMs for 2 Processors, Optimized (317-0236) M-Series Blade Server DIMM Slot Blank, Quantity 6 (317-0373)

Type	Description
	X5560 Xeon Processor, 2.8GHz 8M Cache, Turbo, HT, 1333MHz Max Mem (317-1202) X5560 Xeon Processor, 2.8GHz 8M Cache,Turbo, HT, 1333MHz Max Mem (317-1214) Processor Heatsink, One Required per Processor (317-0354) Processor Heatsink, One Required per Processor (317-0354) 146GB 10K RPM Serial-Attach SCSI 2.5" Hot Plug Hard Drive (341-8715) Windows Server 2008SP2 Standard x64, Incl Hyper-V Incl 5 CALs (421-1084) Onboard Broadcom 5709 Dual Port 1GbE NIC, with TOE (430-3439) 146GB 10K RPM Serial-Attach SCSI 2.5" Hot Plug Hard Drive (341-8715) Windows ServerSP2 2008 Standard Edition, 32 bit and 64 bit Media Kit (421-1094) Add-in SAS6/IR supporting 2HDs SAS - RAID 1 Mirror (341-8854) SAS6/IR Hard Drive Controller Card, For M-Series Blade Servers (341-5690) Basic: Business Hours (5X10) Next Business Day On Site Hardware Warranty Repair 3 Year Extended (989-2373) Basic: Business Hours (5X10) Next Business Day On Site Hardware Warranty Repair Initial Year (992-8770) Dell Hardware Limited Warranty Extended Year (993-6878) Dell Hardware Limited Warranty Plus On Site Service Initial Year (993-6877) DECLINED CRITICAL BUSINESS SERVER OR STORAGE SOFTWARE SUPPORT PACKAGE-CALL YOUR DELL SALES REP IF UPGRADE NEEDED (993-6869) Basic support covers SATA Hard Drive for 1 year only regardless of support duration on the system (994-4019) On-Site Installation Declined (900-9997)
Server Type 3	PowerEdge R610 with Chassis for Up to Six 2.5-Inch Hard Drives (224-4848) PowerEdge R610 Shipping (330-4122) 12GB Memory (6x2GB), 1333MHz Dual Ranked UDIMMs for 2 Processors, Optimized (317-0361) Embedded Broadcom, GB Ethernet NICS with TOE (430-1764) E5520 Xeon Processor, 2.26GHz 8M Cache, 5.86 GT/s QPI, TurboHT (317-0205) E5520 Xeon Processor, 2.26GHz 8M Cache, Turbo, HT, 1066MHz Max Mem (317-1218) PowerEdge R610 Heat Sinks for 2 Processors (317-0211) HD Multi-Select (341-4158) PERC 6/i SAS RAID Controller 2x4 Connectors, Internal, PCIe256MB Cache (341-9254) Performance BIOS Setting (330-3492) Windows Server 2008SP2 Standard x64, Incl Hyper-V Incl 5 CALs (421-1072) iDRAC6 Enterprise (467-8648) DVD ROM, SATA, INTERNAL (313-9092) Bezel (313-7534)
	Dell Management Console (330-5280) Electronic System Documentation and OpenManage DVD Kit (330-3523) RAID 5 for H700 or PERC 6/i Controllers (341-8756) Sliding Ready Rails With CableManagement Arm (330-3520) Basic: Business Hours (5X10) Next Business Day On Site Hardware Warranty Repair 3 Year Extended (989-7033) Basic: Business Hours (5X10) Next Business Day On Site Hardware Warranty Repair Initial Year

Type	Description
	(993-3570) Dell Hardware Limited Warranty Extended Year (993-9458) Dell Hardware Limited Warranty Plus On Site Service Initial Year (993-9457) DECLINED CRITICAL BUSINESS SERVER OR STORAGE SOFTWARE SUPPORT PACKAGE-CALL YOUR DELL SALES REP IF UPGRADE NEEDED (993-9359) Basic support covers SATA Hard Drive for 1 year only regardless of support duration on the system (994-4019) Installation of a Dell Server, Storage or Peripheral Device, PE Server LWT (985-0947) High Output Power Supply Non-Redundant, 717W (330-3519) Power Cord, C13 to C14, PDU Style, 12 Amps, 4 meter, Qty 1 (330-3152) 300GB 10K RPM Serial-Attach SCSI 2.5" Hot Plug Hard Drive (341-8715) 300GB 10K RPM Serial-Attach SCSI 2.5" Hot Plug Hard Drive (341-8715) 300GB 10K RPM Serial-Attach SCSI 2.5" Hot Plug Hard Drive (341-8715) 300GB 10K RPM Serial-Attach SCSI 2.5" Hot Plug Hard Drive (341-8715) 300GB 10K RPM Serial-Attach SCSI 2.5" Hot Plug Hard Drive (341-8715) 300GB 10K RPM Serial-Attach SCSI 2.5" Hot Plug Hard Drive (341-8715) Power Cord, NEMA 5-15P to C13, 15 amp, wall plug, 10 feet / 3 meter (310-8509)
Tape Solution	PowerVault 124T, 2U AutoloaderLTO-3-060 SAS, 400/800GB 16 Slot 2 Magazine (223-8990) SAS 5/E HBA, PCI-Express 2X4 (requires 1 SAS cable) (341-5016) PowerVault 124T Rails for Non-Dell Rack (310-6892) ProSupport for IT: 7x24 HW / SW Tech Support and Assistance for Certified IT Staff, 4 Year (986-3903) Pro Support for IT: Next Business Day Onsite Service After Problem Diagnosis, Initial Year (989-6410) Dell Hardware Warranty, Extended Year(s) (985-7818) Thank you choosing Dell ProSupport. For tech support, visit http://support.dell.com/ProSupport or call 1-800-945-33 (989-3439) Pro Support for IT: Next Business Day Onsite Service After Problem Diagnosis, 3 Year Extended (986-3863) Dell Hardware Warranty Plus Onsite Service Initial Year (985-7799) On-Site Installation Declined (900-9997) Tape Media for LTO3, 400/800GB10 Pack (341-2626)
KVM	16 Port Keyboard/Video/Mouse Digital Switch, 2161DS/2 PowerEdge (222-1659) 1 x USB Server Interface Pod includes CAT5 cable (310-5679) - Quantity 2 Type 3 Contract - Extended Business Day Parts and Labor Onsite Response, 3Year Extended (970-0453) Type 3 Contract - Extended Business Day Parts and Labor Onsite Response, Initial Year (981-8560) Dell Hardware Warranty, Initial Year (985-7929) Dell Hardware Warranty, Extended Year(s) (985-7939) DECLINED CRITICAL BUSINESS SERVER OR STORAGE SOFTWARE SUPPORT PACKAGE-CALL YOUR DELL SALES REP IF UPGRADE NEEDED (991-8529) On-Site Installation Declined (900-9997)
Firewall	ASA 5510 Security Plus Appl with SW, HA, 2GE+3FE, 3DES/AES AC Power Cord (North America), C13, NEMA 5-15P, 2.1m

Type	Description
	ASA 5500 Series Software v8.0 Cisco VPN Client Software (Windows, Solaris, Linux, Mac) ASA 5510 Security Plus License w/ HA, GE, more VLANs + conns ASA/IPS SSM Slot Cover ASA 180W AC Power Supply ASA 5500 AnyConnect Client + Cisco Security Desktop Software ASA 5500 Strong Encryption License (3DES/AES) SMARTNET 8X5XNBD ASA5510 Sec+ w/150 VPN Prs,5FE,3DES/AES
Misc.	1U KMM Console with Touchpad Keyboard and 17 LCD, Versa Rails, Customer Install (310-9963) SMART UPS VT 10KVA 208V W 4 BATT MOD START UP 5X8 (A3217151) BASIC PDU 208V 5.7kw 0U RM 36XC13 6XC19 (A0390498) NETSHELTER SX 42U 600MM WIDE X 1070MM DEEP ENCLOSURE W SIDES BLACK (A1671684) 10 - Microsoft® Windows® Server Standard 2012 License downgraded to 2008R2 (P73-05828) 3 - SYMC BACKUP EXEC 2012 AGENT FOR WINDOWS WIN PER SERVER I/O ESSENTIAL 12 MONTHS 3 -SYMC BACKUP EXEC 2012 AGENT FOR WINDOWS WIN PER SERVER BNDL STD LIC ACAD BAND S ESSENTIAL 12 MONTHS 1-SYMC BACKUP EXEC 2012 SERVER WIN PER SERVER BNDL STD LIC ACAD BAND S ESSENTIAL 12 MONTHS 1-SYMC BACKUP EXEC 2012 SERVER WIN PER SERVER I/O ESSENTIAL 12 MONTHS 1 - Academic VMware vCenter Server 5 Essentials for vSphere 6 - Academic VMware vSphere 5 Essentials PLUS for 1 processor EXPRESS ENDPOINT PROTECTION 11.0 BA ESSENTIAL 12MO (A1295334) ELEC DWNLD ONLY OLP SQL SVR STD EDTN 2008 SNGL NL 1 PROC (A1841104) WHATSUP GOLD PREMIUM 100 DEVICES (A2984874) OLP EXCHGSVRSTD 2010 SNGL NL (A3260047) OLP EXCHG STD CAL 2010 SNGL NL DEV CAL (A3260009)

The quantity and type of each of the main TPLS servers is listed in Table 2, below:

Table 2. Server Allocation

Production System Name	Pre-Production System Name	Description	Model Type	Quantity
I95TP-PW1	I95TP-PW1-PP	Public Web Servers	VM	2
I95TP-NVP1 I95TP-NVP2	I95TP-NVP-PP	IVR Telephony/ Conversation Servers	Type 2	3
I95TP-DI1	I95TP-DI-PP	Data Interface Servers	VM	2
I95TP-XML1	I95TP-XML-PP	IVR Voice/XML Application Servers	VM	2
I95TP-SQL1	I95TP-SQL-PP	MS SQL Servers	VM	2
I95TP-AD1 I95TP-AD2 (shared between prod and pre-prod)		Active Directory Servers	VM	2
I95TP-ADMIN1 (shared between prod and pre-prod)		Backup/Network Management Server	Type 3	1
I95TP-EXCH1 (shared between prod and pre-prod)		Mail Server	VM	1
I95TP-MGMT1	I95TP-MGMT-PP	Management Servers	VM	2
I95TP-VCENTER (shared between prod and pre-prod)		VCenter/Virtualization Management Server	VM	1
VMHOST1 VMHOST2 (shared between prod and pre-prod)		VM Host/Container where all VM's reside	Type 1	2

3.1.2 COTS Software Components

The following generic COTS software is used in support of the TPLS:

- Virtualization Software
  - VMWare vSphere 5 Essentials PLUS – Host virtualization software
  - VMWare vCenter Server 5 Essentials for vSphere – Management software for Virtual Machines, High Availability, and Host Servers

- IVR Software and Associated Subsystems:
  - Nuance Voice Browser – Telephony functions (supports up to 46 simultaneous callers)
  - Voice Web Server (Apache Tomcat server)
  - Nuance Conversation Server – Speech recognition and text-to-speech (TTS)
  - Nuance IVR Management Station
  - XML Server – Data access
  - Telvent IVR Management Server

- Apache Tomcat – Middleware software

- Symantec Backup Exec Agent For Windows Systems – Client backup software

- Symantec Backup Exec 2012 – Server – Backup software
- Symantec Backup Exec Agent For VMware and Hyper-V – VMWare vSphere Host client
- Symantec Endpoint Protection – Anti-virus, anti-malware software
- MS Windows Server 2008R2 64-bit – Operating system software
- MS Exchange 2010 – E-mail notification
- MS SQL Server Standard Edition 2008R2 – Database management, backup, archiving
- What's Up Gold – Network management/monitoring
- AWStats – Website usage analysis and reporting tool
- ApexSQLReport – Database reporting tool
- JBossMQ – JMS messaging server to move callback requests from the database to the Nuance Call Distributor

3.1.3 Server Applications

Table 3, below, shows the COTS software applications and I-95 TPLS system applications that will be installed on each server identified in Table 2, on the previous page.

Table 3. Server Applications

Server Name	Operating System	Type	Purpose	Server Applications
I95TP-PW1	Windows 2008R2	Virtual Machine	Public Web Server	• Public website services • Admin website services • XML file hosting for external feed
I95TP-PW1-PP	Windows 2008R2	Virtual Machine	Public Web Server – Pre-Prod	
I95TP-NVP1	Windows 2008R2	Stand Alone 1x Blade	IVR Telephony/ Conversation Server	• Nuance NVP3 • Call extract process
I95TP-NVP2	Windows 2008R2	Stand Alone 1x Blade	IVR Telephony/ Conversation Server	
I95TP-NVP-PP	Windows 2008R2	Stand Alone 1x Blade	IVR Telephony/ Conversation Server – Pre-Prod	
I95TP-DI1	Windows 2008R2	Virtual Machine	Data Collection/Interface Server	• Data collection services
I95TP-DI-PP	Windows 2008R2	Virtual Machine	Data Collection/Interface Server – Pre- Prod	
I95TP-XML1	Windows 2008R2	Virtual Machine	IVR Voice/XML Application Server	• Tomcat

Server Name	Operating System	Type	Purpose	Server Applications
I95TP-XML-PP	Windows 2008R2	Virtual Machine	IVR Voice/XML Application Server – Pre-Prod	• JBoss-JMS • IVR XML services • IVR callback services • IVR voice services • IVR Manager services
I95TP-SQL1	Windows 2008R2	Virtual Machine	Database Management System	• MS SQL Server 2008R2
I95TP-SQL-PP	Windows 2008R2	Virtual Machine	Database Management System – Pre-Prod	
I95TP-AD1	Windows 2008R2	Virtual Machine	Active Directory Server	• Active Directory services
I95TP-AD2	Windows 2008R2	Virtual Machine	Active Directory Backup Server	• Active Directory services • Whats Up Gold
I95TP-ADMIN1	Windows 2008R2	Stand Alone Server	Tape Backup and Network Management Server	• Symantec Backup Exec • Storage of archived camera snapshots
I95TP-EXCH1	Windows 2008R2	Virtual Machine	E-mail Server for system alerts	• MS Exchange
I95TP-MGMT1	Windows 2008R2	Virtual Machine	Management Server for reporting and IVR management	• TKH video snapshot capture service • IVR Manager • ApexSQL Reports • AWStats • Storage of most recent 30 days of camera snapshots
I95TP-MGMT-PP	Windows 2008R2	Virtual Machine	Management Server – Pre-Prod	
I95TP-VCENTER	Windows 2008R2	Virtual Machine	VMWare Management Server	• Vcenter 5.1
VMHOST1	VMWare 5.1 Essentials Plus	Stand Alone 2x Blade	VM Host	• VM Host
VMHOST2	VMWare 5.1 Essentials Plus	Stand Alone 2x Blade	VM Host	

3.2 Field Equipment

The field equipment used to gather the raw parking space availability information will include the following components:

- *Sensors.* A small sensor "puck" will be installed in each commercial vehicle-designated parking space. The sensor, which fits just beneath the pavement surface, is battery-powered and communicates wirelessly. The sensor will be installed in each parking space by drilling a tiny core of pavement (about 4" wide and 2.5" deep), inserting the sensor puck, and covering the sensor over with a layer of epoxy. Each sensor will continually monitor an individual parking space to determine if the space is occupied or available.

- *Access points.* The sensors communicate wirelessly with the central TPLS platform via one or more access points. The access point is a tiny box that will generally be mounted on a light/utility pole or building rooftop. The access point requires a power source – normally pole-power, solar-power, or combination. It is hard-wired to the cellular modem using an Ethernet cable.

- *Repeaters*. The repeaters will be used to strengthen the wireless signal as the data are transferred from the sensors to the access point. The repeaters, which are battery-powered, will generally be installed on existing infrastructure.

- *Cameras.* Cameras will be used to monitor and "ground-truth" the sensor data, primarily through captured snapshots. They will generally be installed high up on light/utility poles. The camera requires a power source – normally pole-power, solar-power, or combination.

- *Communications equipment.* A cellular modem will be used for communications between the access points in the field and the central platform. The modem requires a power source – normally pole-power, solar-power, or combination.

- *Power supply.* A power supply will be required for the access point, camera and cellular modem. Depending on the power supply options available at the site, the power for the equipment can be provided using a battery-powered Uninterruptible Power Supply (UPS) or direct power from a source such as a light pole using a transformer as required. The most reasonable and economical option for the camera power supply will be chosen after visiting each parking lot and determining the pole locations and specifications.

- *Outdoor equipment cabinet.* A small cabinet, typically mounted near the bottom of a light/utility pole, will house the modem, power equipment, and associated peripherals.

Figure 4, below, depicts the methods for communications between the field equipment and central system.

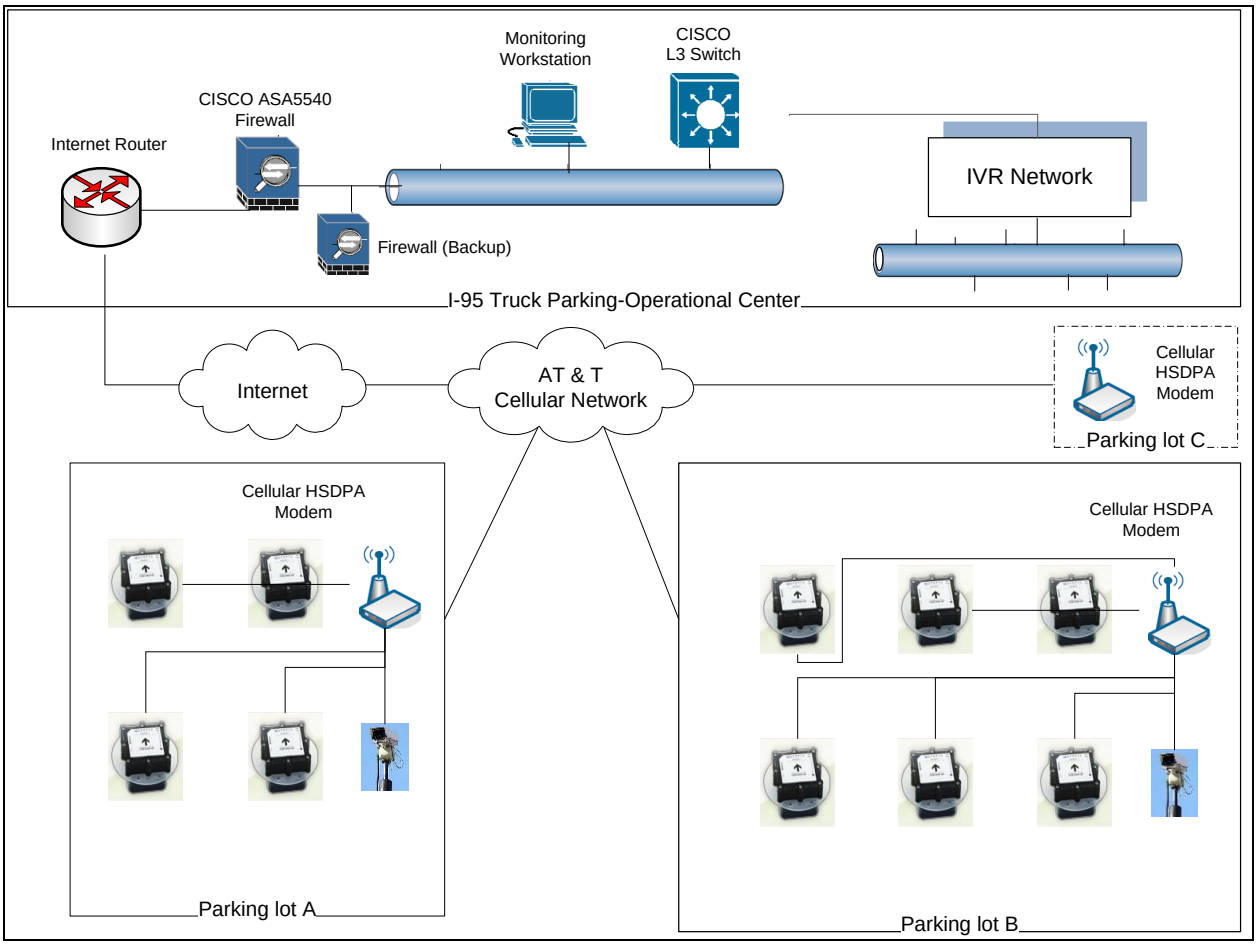


Figure 4. Communications between Field Equipment and Central System

The specifications for each of the components are provided in the sections below.

3.2.1 General Equipment Specifications

Below are some general specifications for the field equipment.

1. Needs to operate on single phase 115V house current.
2. Support for mounting access points, repeaters and cameras on existing poles, building wall or rooftop.
3. Support for cameras to be mounted on poles measuring from 30’ to 120' with necessary wind loading. Specific poles may be different in each state/lot.
4. Support for wired communications via Ethernet direct to cellular modem or wireless communications to Wireless Access Point.
5. Support 100BaseT Ethernet communications.
6. Support the TCP/IP protocol.
7. Support both static IP addressing and HTTP IP addressing.

8. Use XML as the basis for the communications protocol for all sensor commands and responses to include retrieving the sensor identity, the sensor status, and object status for all defined objects.
9. Support the upload and download of a sensor, access point and repeater configuration from a central system. Device configurations will include layouts/locations, radar intensity for the sensors, communications radio settings, parameters, etc.
10. Support the *remote* upload of firmware/software updates to sensors, access points and repeaters.
11. Provide video streaming to the central system. Formats to be supported include H.264/MPEG4 and MJPEG.
12. Support vehicle detection under the following environmental conditions:
    a. Weather – Windy, sunny, cloudy, foggy, rainy, icy, snowy. Must support operation with snow-covered pavement.
    b. Lighting – Variable lighting conditions, daytime, nighttime, reflections
    c. Insect disturbances
    d. Temperature: -20°F – 120°F

3.2.2 Sensor for Monitoring Individual Parking Spaces

Sensors will be positioned in individual parking spaces to provide occupancy status. One sensor will monitor each individual space and be installed approximately 10-15 feet from the front of the space for maximum detection accuracy. Each sensor will be configured during system setup ahead of time. Once a vehicle has stopped in a space, the system detector monitoring the space transmits a status indicating that the space is occupied. Likewise, the status will be changed to unoccupied after a vehicle leaves a detection zone. In near-real-time, vehicle occupancy for each monitored parking space will be calculated and forwarded to the central system for data integration and subsequent processing. An access point will be installed on a pole or a building structure near the parking spaces to gather parking sensor status (occupied/vacant) and sensor vitals. The general specifications for the sensors are as follows.

1. Exchange data wirelessly with an access point or repeater
2. Provide parking space occupancy status through an XML output stream.
3. Detect a change in occupancy status within 30 seconds of a vehicle entering or leaving a parking space (without any movement of an object within the zone).
4. Detect if each configured parking space is occupied by a vehicle within five minutes of system startup.
5. Determine occupancy status for each individual parking space within a specified period of time after the sensor is powered on (without any movement of an object within the space). The sensor should be self-calibrating.
6. Provide for a remote diagnostic capability.

Additional specifications for the sensors are shown in the tables below:

Radio Specifications	
Physical layer protocol	EEE 802.15.4 PHY
Modulation	Direct Sequence Spread Spectrum Offset Quadrature Phase-Shift Keying (DSSS O-QPSK)
Transmit/receive bit rate	250 kbps
Frequency band	2400 to 2483.5 MHz (ISM unlicensed band)
Frequency channels	16
Channel bandwidth	2 MHz
Antenna type	Ceramic patch antenna (mounted below top surface of sensor)
Antenna field of view	±60° (azimuth & elevation)
Nominal output power	+3 dBm
Spurious emissions	• 30 - 1000 MHz: < -56 dBm • 1 - 12.75 GHz: < -44 dBm • 1.8 - 1.9 GHz: < -56 dBm • 5.15 - 5.3 GHz: < -51 dBm
Typical receive sensitivity	-101 dBm

Radar Specifications	
Frequency	6.3 GHz
Bandwidth	>500 MHz
Radiated power	within FCC class B limits
Maximum range	4' (1.2 m) to 10' (3 m) (selectable)
Calibration	self-calibrating
Sample rate	1/2, 1, 2, 4, and 8Hz (selectable)

Power, Physical, & Environmental	
Power supply	• non-replaceable primary Li-SOCI2 3.6V battery pack • 7.2 Ah (nominal capacity)
Dimensions	2.9" x 2.9" x 2.3" (7.4 cm x 7.4 cm x 5.8 cm)
Weight	0.6 pounds / 0.3 kg
Environment	• designed for in-pavement mounting • performance diminishes in standing water and in slushy conditions • NEMA Type 6P enclosure • IP67 ingress protection
Operating temp	-40°F to 176° / -40°C to +85°C

Compliance	
Safety	2006/95/EC

EMC	• FCC: This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation. • 2004/108/EC

3.2.3 Access Point Specifications

The Access Point Controller Card (APCC), along with the APCC radio, maintains two-way wireless links to an installation's sensors and repeaters, establishes overall time synchronization, and transmits configuration commands and message acknowledgements.

Functional Specifications	
Interfaces	• communicates with traffic controller via 2x22 pin edge connector to backplane • (2) rs-422 full duplex to apcc radio(s) via rj45 connector • (2) usb 2.0 full speed • rs-485 full duplex to ex cards via rj45 connector • 10/100base-t network access via rj45 connector • to/from configuration device (pc) via tcp/ip over 10/100base-t Ethernet • to/from central network management / data collection facilities via tcp/ip —10 /100base-t Ethernet —cellular data modem
IP connectivity	• http, ppp, pptp, ssh, optional encryption over tunnel • 10/100base-t via rj45 connector • gsm gprs connectivity (optional) —dual-band 850/1900 mhz gsm (n. American version) —dual-band 900/1800 mhz gsm (int'l version) —up to 85.6 kbps • cdma2000 1xrtt connectivity (optional) —dual-band 800/1900 mhz cdma(per specific cellular service provider) —up to 153.6 kbps
Per-lane data processing	• counts (volume) • occupancy • average and median speeds • binned speeds and vehicle lengths over selectable time intervals
Per-vehicle data processing	• initial vehicle detect time • gap • speed • length

Memory processor	• 400 mhz arm9 processor • linux 2.6 operating system • 1 gb flash • 64 mb ram
Physical layer protocol	Ieee 802.15.4 phy
Modulation	Direct sequence spread spectrum offset quadrature phase-shift keying (dsss o-qpsk)
Transmit/receive bit rate	250 kbps
Frequency band	2400 to 2483.5 mhz (ism unlicensed band)
Frequency channels	Up to 16
Channel bandwidth	Up to 2 mhz
Antenna type	Microstrip patch antenna (behind front face panel)
Antenna field of view	±60° (azimuth & elevation)
Nominal output power	0 dbm
Spurious emissions	• 30 - 1000 mhz: < -36 dbm • 1 - 12.75 ghz: < -30 dbm • 1.8 - 1.9 ghz: < -44 dbm • 5.15 - 5.3 ghz: < -47 dbm
Typical receive sensitivity	-101 dbm (per ≤ 1%)
Saturation(max input level)	≥ 10 dbm

Power, Physical, & Environmental	
Input voltage	• 22-26 vdc (24vdc nominal) • 9-15 vdc (12 vdc nominal)
Power consumption	Less than 700 mw (min w/out cell modem)
Dimensions	• single-slot: 7” x 4.5” x 1.1” (18cm x 11.4 cm x 3 cm) • double-slot: 7” x 4.5” x 2.3” (18 cm x 11.4 cm x 6 cm) (optional) • apcc-spp: 4.7” x 3.5” x 2.4” (12 cm x 9 cm x 6 cm) • isolator: 6.5” x 3” x 1.3” (17 cm x 8 cm x 3 cm)
Weight	• single-slot: 7.9 oz (224 g) • double-slot: 10.5 oz (298 g) • apcc-spp: 14.1 oz (400 g) • isolator: 5.6 oz (159 g)
Environmental	TBD
Operating temp	Industrial -40°c to 80°c

Compliance	
Safety	2006/95/EC

EMC	• FCC: This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation. • 2004/108/EC

3.2.4 Repeater Specifications

In cases where one or more installed wireless sensors are out of range of the nearest access point, one or more repeaters can be used to provide a two-way relay between the out-of-range sensors and the access point. As many as two repeaters operating in tandem can be installed between a sensor and the access point. To simplify its deployment, a repeater is battery powered and thus requires no wires or cabling.

Functional Specifications	
Interfaces	• to/from sensors via 802.15.4 phy radio • to/from repeaters via 802.15.4 phy radio • to/from access point via 802.15.4 phy radio
Physical layer protocol	Ieee 802.15.4 phy
Modulation	Direct sequence spread spectrum offset quadrature phase-shift keying (dsss o-qpsk)
Transmit/receive bit rate	250 kbps
Frequency band	2400 to 2483.5 mhz (ism unlicensed band)
Frequency channels	16
Channel bandwidth	2 mhz
Antenna type	Microstrip patch antenna (behind front face panel)
Antenna field of view	±60° (azimuth & elevation)
Nominal output power	0 dbm
Spurious emissions	• 30 - 1000 mhz: < -56 dbm • 1 - 12.75 ghz: < -44 dbm • 1.8 - 1.9 ghz: < -56 dbm • 5.15 - 5.3 ghz: < -51 dbm
Typical receive sensitivity	-95 dbm (per ≤ 1%)
Saturation (max input level)	≥ 10 dbm

Power, Physical, & Environmental	
Power supply	• user-replaceable primary li-socl2 3.6v battery pack —nominal capacity: 57 ah
Dimensions	4.72” x 3.54” x 3.15” (13.4 cm x 10.6 cm x 13.5 cm)
Weight	• 1.8 lbs (0.8 kg) • mounting kit: add’l 1.2 lbs (0.5 kg)

Environmental	• designed for weatherproof, outdoor operation • nema type 4x enclosure • ip65 ingress protection
Operating temp	-40ºf to 176ºf / -40ºc to +80ºc

Compliance	
Safety	2006/95/ec
EMC	• FCC: this device complies with part 15 of the fcc rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation. • 2004/108/ec

3.2.5 CCTV Camera Specifications

Cameras will be installed on light/utility poles, where possible, to monitor and "ground-truth" the sensor data. The camera requires a power source – normally pole-power, solar-power, or combination. Cameras will be used to validate sensor outputs using the least number of cameras with PTZ capabilities based on proper camera positioning.

To preserve bandwidth and minimize telecommunication costs, primarily only video snapshots will be transmitted to the central system at a configurable periodic interval of at least one frame per minute instead of continuous streaming video. The initial default interval will be one frame per minute. Video snapshot transmissions will be via Ethernet communications. The cameras will be configured with tours with multiple views to cover different areas of the parking lot to minimize the overall number of cameras needed. Note that video snapshots can be stored for up to 24 hours.

Detailed camera specifications are as follows.

Camera	
Image sensor	1/4" CCD
Lens	f=3.8 – 46 mm, F1.6 – 2.7, autofocus, automatic day/night
Horizontal angle of view	51.6° - 4.4°
Minimum illumination	Color: 1 lux at 30 IRE F1.6 B/W: 0.3 lux at 30 IRE F1.6
Shutter time	1/50000 s to 4/3 s (60 Hz), 1/50000 s to 8/5 s (50 Hz)
Pan/tilt/zoom (PTZ)	E-flip, Auto-flip, 100 preset positions Pan: 360° (with Auto-flip), 1.8° - 100°/s Tilt: 180°, 1.8° - 100°/s 12x optical zoom and 4x digital zoom, total 48x zoom
Pan/tilt/zoom functionalities	Limited guard tour Control queue On-screen directional indicator

Video	
Video compression	H.264 (MPEG-4 Part 10/AVC) Motion JPEG
Resolutions	704x480 to 176x120 (60 Hz) 704x576 to 176x144 (50 Hz)
Frame rate	H.264: Up to 30/25 fps (60/50 Hz) in all resolutions Motion JPEG: Up to 30/25 fps (60/50 Hz) in all resolutions
Video streaming	Multiple, individually configurable streams in H.264 and Motion JPEG Controllable frame rate and bandwidth VBR/CBR H.264
Image settings	Manual shutter time, compression, brightness, sharpness, white balance, exposure control, backlight compensation, fine tuning of behavior at low light, rotation, aspect ratio correction, text and image overlay, image freeze on PTZ

Network	
Security	Password protection, IP address filtering, HTTPS encryption, IEEE 802.1X network access control, digest authentication, user access log
Supported protocols	IPv4/v6, HTTP, HTTPS, SSL/TLS, QoS Layer 3 DiffServ, FTP, SMTP, Bonjour, UPnP, SNMPv1/v2c/v3 (MIB-II), DNS, DynDNS, NTP, RTSP, RTP, TCP, UDP, IGMP, RTCP, ICMP, DHCP, ARP, SOCKS

System Integration	
Application Programming Interface	Open API for software integration
Intelligent video	Video motion detection, Advanced Gatekeeper
Alarm triggers	Video motion detection, PTZ preset, temperature, memory card full
Alarm events	
File upload via FTP, HTTP and email	Notification via email, HTTP and TCP Go to PTZ preset, run guard tour, record to local storage Pre- and post-alarm video buffering

General	
Casing Acrylic (PMMA) clear dome	IP51-rated aluminum and plastic casing IP66- and NEMA 4X-rated aluminum and plastic casing, sunshield (PC/ASA)
Memory	256 MB RAM, 128 MB Flash
Power	Power over Ethernet IEEE 802.3af Class 3 20-24 V AC, max. 23.4 VA; 24-34 V DC, max. 15.6 W
Connectors	RJ-45 for 10BASE-T/100BASE-TX PoE
Local storage	SD/SDHC memory card slot

Operating Conditions	
Temperature	-20 °C to 50 °C (-4 °F to 122 °F)
Humidity	15-100% RH (condensing)
Approvals	EN 55022 Class B, EN 61000-3-2, EN 61000-3-3, EN 61000-6-1, EN 61000-6-2, EN 55024, FCC Part 15 Subpart B Class B, ICES-003 Class B, VCCI Class B, C-tick AS/NZS CISPR 22, EN 60950-1, KCC Class B
Weight	1kg (2.4 lb.) to 2kg (3.5 lb.)

3.2.6 Data Communications

The cellular approach is the most efficient way to send low bit-rate data and video from the sensor and camera units in the field to the central system. The 3G network uses HSDPA/UMTS technology (High Speed Downlink Packet Access/Universal Mobile Telecommunications System) which has been widely deployed since 2006.

The proposed communication device for this project is the "Airlink Pinpoint X" wireless modem, a commercial-grade 3G cellular router which provides secure high speed wireless connectivity. This cellular router supports both CDMA EV-DO and GSM HSDPA/UMTS 3G networks and can be used for primary wireless broadband network connectivity to access points or cameras at each truck parking lot.

3.2.6.1 Cellular Modem

The cellular modems will conform to the following specifications:

Security and Intelligence

- IPsec VPN
- GRE Tunneling
- Events Reporting Engine
- Routing Protocols
- Highly Configurable

Technology

- HSUPA with fallback to:
- HSDPA, UMTS, EDGE, GPRS
- (MS-12), GSM
  or
- EV-DO Rev. A with fallback to:
- CDMA 1X EV-DO Rel 0,
- CDMA 1xRTT, CDMA IS-95

Bands

- Tri-Band UMTS/HSDPA/HSUPA 850, 1900, 2100 MHz
- Quad-Band GPRS/EDGE
- 850, 900, 1800, 1900 MHz

- Dual-Band UMTS/HSDPA
- 850, 1900 MHz

or

- Dual-Band EV-DO Rev. A 800, 1900 MHz

Environmental

- Operating Temperature:
- -30° to +70°C / -22° to +158°F
- Storage Temperature:
- -40° to +85°C / -40° to +185°F

Dimensions

- 162 mm x 40 mm x 109 mm
- 6.4 in x 1.6 in x 4.3 in
- 612 grams
- 21.5 oz

Standards/approvals

- FCC
- CE (EU-SKU)
- Industry Canada
- Mil-Std 810F
- RoHS
- Carrier Specific Approvals

Host interfaces

- Ethernet: 10/100 Mbps RJ-45
- RS-232: DB9 DCE (300-230400 baud)
- I/O: 4 Digital, 4 Analog, 2 Relay
- Antenna Connections:
    - Cellular - 50 Ohm TNC
    - GPS - 50 Ohm SMA
    - Receive Diversity - 50 Ohm SMA

Application interfaces

- TCP/IP, UDP/IP, DHCP, HTTP,
- SNMP, SMTP, SMS, MSCI, NMEA,
- TAIP, GPS, Binary

3.2.7 Power Supply

The specifications for a Smart UPS are provided below. The UPS will include functionality for remote monitoring, alarms, and reset of the UPS via a cellular modem. The proposed UPS for this project is the “Intellipower SmartITS” UPS.

AC & DC Inputs	
Operating AC Input Voltage Range	120-277 vac +/- 15% (utility AC)
Frequency	47 ~ 63 hz
Maximum Input Current	1.6A
AC Input Circuit Breaker Rating	3A
AC Input Connector	3 position terminal block for Line 1, Line 2 & Earth Ground wires

DC Outputs from the UPS	
UPS Output	12-24 vdc +/-5%, 2A max. (24 watts maximum)
Power Efficiency in Utility AC Mode	78% (AC to DC and DC to DC converters)
Power Efficiency in Battery Mode	85% (DC to DC converters)

Battery & Battery Charger	
Battery Type & Capacity	Two 12 volt, 50AH gel-cell batteries (24 volt, 50AH)
Battery Runtime	About 24 hours for 30 watt average load
High-Capacity Battery Charger	Included (temperature sensor & microprocessor controlled smart battery charger system)
Temperature-compensated battery charger	7A maximum charging rate Automatically selects voltage between 25~29 vdc as final battery voltage (depending on battery temperature)
Other	LED indicators Alarm signals

Mechanical
A wall-mountable metal cabinet, light grey painted Rated NEMA compliant enclosure (for use in all outdoor conditions)
Two cable (or conduit) entry holes are provided at the side/bottom of the cabinet
One 1/2" diameter hole for AC input
One 1/2" diameter hole for DC output

Environmental	
Operating Temperature	-20°C to 55°C (ambient air temperature)
Storage Temperature	-20°C to 60°C
Other	Surge voltage immunity Withstands test conditions without damage to itself (or to connected load equipment) ANSI/IEEE C62.41-1991 6kV, 3kA, Category B3

3.2.8 Outdoor Equipment Cabinet

The equipment box will house the cellular modem for communicating data to the central system, power supply, and wireless communications equipment if needed.

Specifications

- Compression-molded fiberglass has outstanding chemical and temperature-resistance qualities and exhibits excellent weatherability and physical properties
- Fiberglass is easily punched, drilled, filed, or sawed
- Gasket assures water-tight and dust-tight seal
- Polyester mounting brackets and stainless steel attachment screws are provided with each enclosure
- Scratch-resistant polycarbonate windows are permanently bonded in place
- Molded-in-place threaded brass inserts and plated steel screws are provided for mounting optional panels and terminal block kits
- Removable hinged cover attached to body with Type 316 stainless steel hinge pin
- Screw-cover enclosures are secured with two captivated Type 316 stainless steel slotted cover screws
- Enclosures with patented quick-release latches have corrosion resistant polyester latches located in corners that provide unobstructed access to enclosure
- Hinge pin and bail are corrosion-resistant Type 316 stainless steel
- Padlock provisions included in each latch

Finish

- Fiberglass material is light-gray inside and out.

3.3 System Hosting

For the initial Tier I operation of the TPLS, the central system will be hosted at Telvent's headquarters office located at:

Telvent/Schneider Electric
1390 Piccard Drive, Suite 200
Rockville, Maryland 20850

This location will house all system hardware, networking, and communications (data and voice) equipment. A key card security system is in place in this facility to prevent unauthorized access. In addition, racks housing the equipment will be enclosed and protected through keyed access.

During Tier I, the I-95 project team will evaluate the effectiveness of the hosting facility and determine whether there is a need to migrate the hosting of the system to another facility for the Tier II operation.

4 Data Collection and Integration Design

This section contains the design of the Data Collection and Integration sub-system of the I-95 Truck Parking Location System.

The selected technology for the initial release of the TPLS is the VSN240 Wireless Flush Mount sensors from Sensys Networks. Sensys will provide a SNAPS Professional server hosted and maintained at the Sensys facility located in Berkeley, CA that will communicate with all of the sensors via wireless access points installed in each parking lot, and retrieve all individual sensor data. SNAPS Professional is an integrated software solution for managing Sensys Networks detection networks. It provides automated statistical processing of all vehicle detection data, remote network monitoring, and lifecycle management for all Sensys Networks devices. A single SNAPS server can support up to 200 wireless access points. Additional SNAPS servers can be configured to support additional wireless access points and additional parking lots as the need arises.

The architecture of the system is designed to support the data flow and processing for up to a maximum of 500 parking lots, with up to 500 parking spaces per lot.

4.1 SNAPS Interface

SNAPS will provide individual parking space occupancy data via a REST URL (Representational State Transfer Uniform Resource Locator) call from the central system.

Before data can be requested, SNAPS will require a log in. After a successful login, the data interface will be able to request real-time parking space information. The interface defined for this project is:

Request:

Options for usage of "gt_do2.cgi":

Field Name	Definition	Project Use
site=[xxx]	project customer location	One or more unique ID's will be defined for the I-95 Truck Parking system.
Ts	=[epoch timestamp since 1970] - (optional) select point in time - if empty, use current time	This project is initially only concerned with current availability, so the "ts" option will not be utilized.
do=[get|mget]	get is single id (space or sensor); mget means multiple spaces at once.	This project will collect all space data in one request, and parse the full set, so the mget option will be utilized.

Field Name	Definition	Project Use
mode=[spaces| sensors]	run on space or sensor databases	As the design is for each space to be monitored by a single sensor, sensors and spaces are functionally equivalent. Therefore, the data collection component will collect data for spaces. The "spaces" option will be used.
spaces=[spaceid1, spaceid2, spaceid3...]	comma separated list of space identifiers. If the spaces field is not populated, the default action will be to return all available spaces.	This project will process all spaces at one time. If the number of spaces in the system grows to where this is not an efficient method, this option will be changed to separate the spaces into logical groupings.
overstay=[seconds_for_space1, seconds_for_space2, seconds_for_space3,..]	a comma separated list of times (in seconds) that correspond to the space identifiers, used to flag overstay in output parameter "overstaystate" or "moverstaystate"	Not used for this project.

Typical REST call:

http://snapsx.sensysnetworks.net/mrp/bin/gt_do2_x.cgi?do=mget&site=telvent-chesapeakehouse&mode=spaces

Response:

Field Name	Definition	Project Use
Do=[get|mget]	single id or multiple id in the request	Validate input request
Ts	=[epoch timestamp since 1970] – time of the data returned. If ts is defined on the request, the requested value will be returned here. If ts is NOT on the input, the current time will be returned.	Only utilized to check if SNAPS is returning current time.
State [0|1|-1]	Only returned if do = "get" 1 = space occupied 0 = space unoccupied -1 = invalid space ID, or no data available	Not used in initial release.
mstate=[0|1|-1,0|1|-1,0|1|-1,...] -	comma separated list of occupied (=1), empty (=0) spaces, unknown (=-1)	This field contains the current state of each space. These values will be stored in the database and used to calculate the available spaces in each lot.

Field Name	Definition	Project Use
mdur=[seconds1, seconds2, seconds3,...]	session duration for each space. If ts = real-time, duration goes until real-time.	Not used.
movestaystate=[0|1,0|1,0|1,...]	list of overstay state violators per space – in violation = 1, no overstay violation = 1	Not used.
Mode = [spaces|sensors]	From request	Validate input request.

Typical REST response:

<opt do="mget" mdur="33333,33328,33327,33316,25126" mode="spaces" mstate="0,0,0,0,0" site="telvent-chesapeakehouse" space="1,2,3,4,5" ts="1368807662"/>

4.2 Data Collection/Integration Process

The data collection/integration process consists of a Java application running on a Windows platform, and database update procedures. It has the following requirements:

1. Collect parking space data
2. Store current parking space data
3. Store historical data based on a defined time period
4. Create XML feed files for use by external systems

Initially, the data collection/integration process reads through the "tblManagedParkingLot" database table, communicates with each "parking space management system" in the Data Collection system, and retrieves parking space occupancy data. To accommodate potential future data collection technologies, the overall structure of the Data Collection system and associated database tables have been designed to accommodate additional vendor "parking management systems" if/when they become available. If there are multiple parking management systems, the raw parking space data might be in different formats, and therefore, the data collection process will need to convert data from different sources into a standardized system format. Currently, only the Sensys Networks sensor technology is utilized in the system.

On a configurable timed basis, initially once per minute, the data collection/integration process logs on to the SNAPS server and requests information on all available parking spaces in the system. If there are no errors, the parking space occupancy data is stored in the "tblParkingSpace" database table for each parking space. When all spaces have been updated, a process summarizes the parking lot data and updates the "tblDynamicParkingInfo" table, which is then read by the public website, IVR telephone system, and XML data file extraction process.

When the data collection process encounters a problem in communicating with the parking space management system after a period of time, the process will send out an SNMP (Simple Network Management Protocol) trap alert as well as mark the communication failure in the "CommStatus" field of the "tblSensorManagementSystem" table.

The data collection process contains two scheduled jobs. They will be run according to the properties in the system configuration file. The first scheduled job is to copy data from the "tblDynamicParkingInfo" table into the "tblHistoricalParkingInfo" table. Data can be retained in the "tblHistoricalParkingInfo" table for a configurable period of time, and the system will be initially configured to retain data for one year. The second scheduled job is to check the "tblExportSchedule" table and generate the XML external data feed. The details of the external data feed process are provided in Section 5.3, External Data Feed.

4.3 Error Handling

There are several error conditions that must be handled by the data collection process.

- SNAPS Server Failure. If the SNAPS server is ever in a state where it does not respond to requests, the system will raise a major alert by sending an SNMP trap to the system monitoring tool, What's Up Gold, which will notify the O&M operators.

- Access Point Failure. If the system determines that an access point is not sending detector status, the system will also raise an alert. There are two methods for determining this. One, the SNAPS server has the ability to report detected failures. If the SNAPS server reports that one or more access points has stopped reporting, the system will also send an alert. The other method is to cycle through each access point in the system and check if all of the detectors associated with an access point are not reporting. If this is detected, the system will raise an alert.

- Sensor Failure. If one or more single detectors are not reporting status for a defined period of time, the system will raise a minor alert. The system can continue to operate if only a small number of detectors has failed.

4.4 Sensor Configuration and Monitoring

Sensys provides tools with a wealth of capabilities to assist with configuring and monitoring the detectors and their infrastructure. TrafficDOT is the primary tool that will be used. Using TrafficDOT, administrators will be able to configure, monitor, and reset sensors and allow administrators to configure, monitor, and reset communication access points. TrafficDOT uses industry-standard TCP/IP communications to remotely connect with the sensors and access points. The TPLS Administration website will include embedded links to TrafficDOT to allow system administrators to quickly jump to the correct TrafficDOT features based on selected spaces or devices.

In addition, TrafficDOT will be configured to automatically detect errors and send SNMP alerts to system administrators whenever defined errors are detected.

4.5 Common System Tables

The database tables common to all components of the system, including data collection, IVR telephone system, public website, and Administration website are described below.

4.5.1 tblVendorSystem

This table stores the list of parking space management systems. It contains the details about the vendor system. There is one record per system.

Column Name	Type	Description
SystemID	nvarchar NOT NULL	Primary key
Name	Nvarchar NOT NULL	Name of the Vendor
Vendor	nvarchar	ID of the Vendor
URL	nvarchar	URL for the Vendor Data Web Service
CommStatus	nvarchar	Current status of the connection to the vendor

4.5.2 tblManagedParkingLot

This table stores parameters for data collection used in communication with the in-ground sensors. There is one record per parking lot in this table.

Column Name	Type	Description
NodeID	Nvarchar NOT NULL	Primary Key and foreign key to tblGeoPointInfo
SystemID	Nvarchar NOT NULL	Primary key and foreign key to tblVendorSystem
Parameter	nvarchar	Parameter for getting data
UserID	nvarchar	User ID for logging in
Password	nvarchar	Password for logging in

4.5.3 tblParkingArea

This table stores information on the defined parking areas. Each parking lot has one or more areas.

Column Name	Type	Description
AreaID	Nvarchar (32) NOT NULL	Primary Key
AreaName	Nvarchar (64) NOT NULL	Name of the parking area
AreaDescription	Nvarchar (128)	Description of the parking area

4.5.4 tblParkingSpace

This table stores parking space information and its current status. There is one record per parking space per instrumented parking lot.

Column Name	Type	Description
SpaceID	nvarchar(32) NOT NULL	Primary key - Space ID (unique among all parking lots)
NodeID	nvarchar(32) NOT NULL	ID of the parking lot
DetectorID	nvarchar(32) NOT NULL	ID of the detector in the space
Status	int	0 empty, 1 occupied, -1 unknown
CameraPresetID	int	Foreign key into tblCameraPreset table. This will represent the camera and preset with the best view of the parking space
URL	Nvarchar(128)	URL to configure detector
LastUpdatedTime	datetime	Timestamp when the entry was recorded
Enabled	bit	indicate online '1' or 'offline' '0
AreaID	nvarchar(32) NOT NULL	Area ID of the parking space

4.5.5 tblHistoricalParkingInfo

This table stores dynamic information such as status and number of parking spaces available in a parking lot. There is one record per parking lot. The uniqueness of each record is enforced through a separate index.

Column Name	Type	Description
NodeID	nvarchar(32) NOT NULL	Primary Key - ID of the parking lot
AreaID	nvarchar(32) NOT NULL	Primary Key - ID of the parking area
PkgVehicleType	int	Vehicle type can be: 1 – Truck 24 – (oversized) Extra Large Truck 3 – (large) RV Etc.
PkgLotStatus	int	0 – lot off line 1 – parking information available 2 – parking information partially available
PkgLotSpacesAvailable	int	Parking spaces available
PkgLotSpacesOccupied	int	Parking spaces occupied
PkgLotSpacesUnknown	int	Parking spaces unknown
PkgLotSpacesOffline	int	Parking spaces offline

Column Name	Type	Description
SnapshotTime	Datetime NOT NULL	Primary Key Timestamp when the entry was recorded

4.5.6 tblHistoricalParkingSpaceInfo

This table stores historical parking space information. There is one record per timestamp per space. The uniqueness of each record is enforced through a separate index based on SpaceID and Timestamp.

Column Name	Type	Description
SpaceID	nvarchar(32) NOT NULL	ID of the space
Status	int	Status of the space: 0 = available 1 = occupied -1 = unknown -2 = offline
Timestamp	datetime	Timestamp when the entry was recorded

4.5.7 tblDynamicParkingInfo

This table stores current space status information. There is one record per parking lot.

Column Name	Type	Description
NodeID	nvarchar(32) NOT NULL	Primary Key ID of the Parking Lot
AreaID	nvarchar(32) NOT NULL	Primary Key ID of the Parking Area
PkgLotStatus	int	0: lot off line (manually) 1: parking information available 2: parking information partially available 3: parking information unknown/not available
PkgLotSpacesAvailable	int	Number of available spaces
PkgLotSpacesOccupied	int	Number of occupied spaces
PkgLotSpacesUnknown	int	Number of unknown spaces
PkgLotSpacesOffline	int	Number of offline spaces

4.5.8 tblUsefulSite

This table stores a list of websites that will be used by system administrators. There is one record per website.

Column Name	Type	Description
SiteName	nvarchar(64) NOT NULL	Primary Key - Name of site
SiteLink	nvarchar(768) NOT NULL	URL of the site

4.5.9 tblCameraPreset

This table stores a list of camera presets. There is one record per preset per camera.

Column Name	Type	Description
CameraPreSetID	Int NOT NULL	Primary Key - Unique ID of preset among all cameras for all parking lots
CameraID	nvarchar(32) NOT NULL	ID of the camera
PresetID	nvarchar(32) NOT NULL	Preset number
Description	nvarchar(128)	Description of the preset (e.g., what direction the camera is looking)
URL	nvarchar(128)	URL to configure camera
CameraImage	nvarchar(50)	Name of the graphic file template associated with the camera preset

4.5.10 tblDevices

This table stores a list of devices (e.g., access points, UPS', modems). There is one record per device.

Column Name	Type	Description
DeviceID	nvarchar(32) NOT NULL	Primary Key - ID of Device
DeviceTypeID	Int NOT NULL	ID of DeviceType
NodeID	nvarchar(32)	Lot where device located
Manufacturer	nvarchar(64)	Name of device Manufacturer
Model	nvarchar(32)	Model of the device
Status	Int	Online/offline
ConfigureURL	nvarchar(128)	URL to configure device
VideoStreamURL	nvarchar(128)	Cameras Only – URL to view video stream

4.5.11 tblDeviceType

This table stores a list of device types. There is one record per device type.

Column Name	Type	Description
DeviceTypeID	Int NOT NULL	Primary Key - ID of DeviceType
DeviceType	nvarchar(64) NOT NULL	Description of Device Type

4.5.12 tblGraphics

This table stores a list of graphics files (e.g., for parking lot layout) used for display on the Administration website. There is one record for each file.

Column Name	Type	Description
GraphicName	nvarchar(32) NOT NULL	Primary Key - name of Graphic File
NodeID	nvarchar(32) NOT NULL	Lot where image was taken
Description	nvarchar(128)	Description of image
DefaultOne	Bit	If set, this is the graphic that will show for the parking lot

4.5.13 tblGeoPointInfo

This is a generic table that is used for parking lots and other geographical points such as a rest area or weigh station. This table stores the information for each individual parking lot. Each parking lot is given a unique Node ID that is then used in subsequent tables to identify an individual parking lot. There is one record per parking lot.

Column Name	Type	Description
NodeID	Nvarchar(32) NOT NULL	Primary key for the table
RoadName	Nvarchar(128)	Road name that facility is located on.
RouteCode	Nvarchar(50)	Specifies the route code. Not used in this project. Will be set to Null.
Direction	Nvarchar(22)	Direction of facility on interstate. The values are: N – North S – South E – East W – West Both – (North and South) or (East and West)
MileMarker	float	Nearest mile marker to the facility. This is not used presently.
FromLoc	Nvarchar(128)	The lot is located between the FromLoc and ToLoc
ToLoc	Nvarchar(128)	The lot is located between the FromLoc and ToLoc

Column Name	Type	Description
FromExit	Nvarchar(128)	The lot is located between the fromExit and ToExit
ToExit	Nvarchar(128)	The lot is located between the fromExit and ToExit.
Latitude	Float	Latitude of Lot
Longitude	Float	Longitude of Lot
Article	Nvarchar(64)	This field is used by IVR to say article such as ‘nearest’, ‘to’, or ’from’ to get location of facility – related to fromLoc.
NearestCity	Nvarchar(128)	The nearest city to the parking lot.
City	Nvarchar(128)	The city of the parking lot.
County	Nvarchar(128)	The county of the parking lot.
ToCity	Nvarchar(128)	This is not used presently. It can be used by IVR in the future.
NoOfAssociatedLinks	Int	This is not used presently. It can be used by IVR in the future.
LocationType	Nvarchar(24)	This is not used presently. It can be used by IVR in future
LocationName	Nvarchar(128)	Long name of lot
FacilityName	Nvarchar(128)	Not used
Status	Nvarchar(24)	This field will not be used in this project and will be set to Null. For the status of the parking lot, refer to the status defined in tblDynamicParkingInfo.
Description	Nvarchar(1024)	More detailed description of the lot
PhoneNumber	Nvarchar(15)	Parking lot phone number.
LocationName	Nvarchar(256)	This gives the information where the parking lot is, for example, Xxx parking lot at exit 53 on I-95.
DirectionsRecordingName	Nvarchar(50)	Optional name of voice file containing directions to the parking lot from the freeway.
DirectionsText	Nvarchar(1024)	Text describing the directions to the parking lot from the freeway.
LastUpdate	Datetime	Date/time the record was last updated.
Export	bit	Boolean flag indicating if the parking lot data is to be exported.

4.5.14 tblDetailedInfo

This table lists all the amenities provided by each parking lot. There is one record per amenity per parking lot.

Column Name	Type	Description
NodeID	nvarchar(64) NOT NULL	Primary Key ID of Parking Lot
FeatureID	Int NOT NULL	Primary Key Unique ID for the feature. For this project, it will be TruckParking Amenity
DINameID	Int NOT NULL	Primary Key ID for the specific feature, e.g., Restaurant
StartValue	nvarchar(512)	Optional Value or Start of range if end Value populated
EndValue	nvarchar(512)	End of Range
DIUnitID	int	Optional ID for units such as # of spaces, gasoline price
Order	Int	Order in which amenities will be displayed
UpdateDttm	datetime	Last time the amenities were updated

4.5.15 tblVehicleType

This table stores the list of valid vehicle types. For Tier I, the system will implement only one type (Truck). There is one record for each vehicle type.

Column Name	Type	Description
VehicleTypeID	Nvarchar(24) NOT NULL	Primary Key Unique ID for the Vehicle Type
VehicleTypeName	Nvarchar(24)	Name of the POI Type (e.g.

4.5.16 tblDetailedInfoNameLookup

This table stores the list of valid Detail types. For truck parking, these will include items such as Restaurant, Washing Machines, etc. There is one record per Detail type.

Column Name	Type	Description
DetailTypeID	int NOT NULL	Primary Key Unique ID for the Detail Type
DetailName	Nvarchar(128) NOT NULL	Name of the detail type

4.5.17 tblDetailedInfoUnitLookup

This table stores the list of valid Unit types. For truck parking, these will include items such as the number of spaces, $ amount, weight in pounds, etc. There is one record per Unit type.

Column Name	Type	Description
UnitTypeID	Int NOT NULL	Primary Key Unique ID for the Unit Type
UnitName	Nvarchar(128) NOT NULL	Name of the unit type

5 Data Dissemination Design

This section presents the design for the Data Dissemination sub-system of the I-95 Truck Parking Location System. Truck parking availability information will be disseminated via an IVR telephone system, public website, and external data feed.

5.1 IVR Telephone System

The IVR telephone system serves as one of the primary data dissemination methods for the I-95 Truck Parking Location System. It provides parking availability information through a series of easily understood questions and answers based on live speech, concatenated speech, and text-to-speech. All prompts and responses are in English. The system is designed to recognize speech-based and touch-tone user responses and supports a "barge-in" capability that allows the caller to interrupt messages to select the desired option. The system also accepts call transfers from other systems, such as 511 systems. Additionally, an automatic call-back system will update truck operators on parking space status at the specified parking lots as commercial vehicle drivers progress through their trips. The IVR telephone system will be available to callers through a toll-free number (i.e., 855-TRK-PARK).

The IVR telephone system call flows for the I-95 TPLS are shown in Appendix D. These diagrams depict how the user interacts with the system, and the system logic used in providing the necessary information to the user.

Figure 5, below, shows the software components of the I-95 Truck Parking IVR telephone system.

1. Inbound Process
2. Outbound Process
3. Database
4. Nuance Call Distributor
5. Nuance Voice Platform (NVP) – Conversation Server and Telephony Gateway

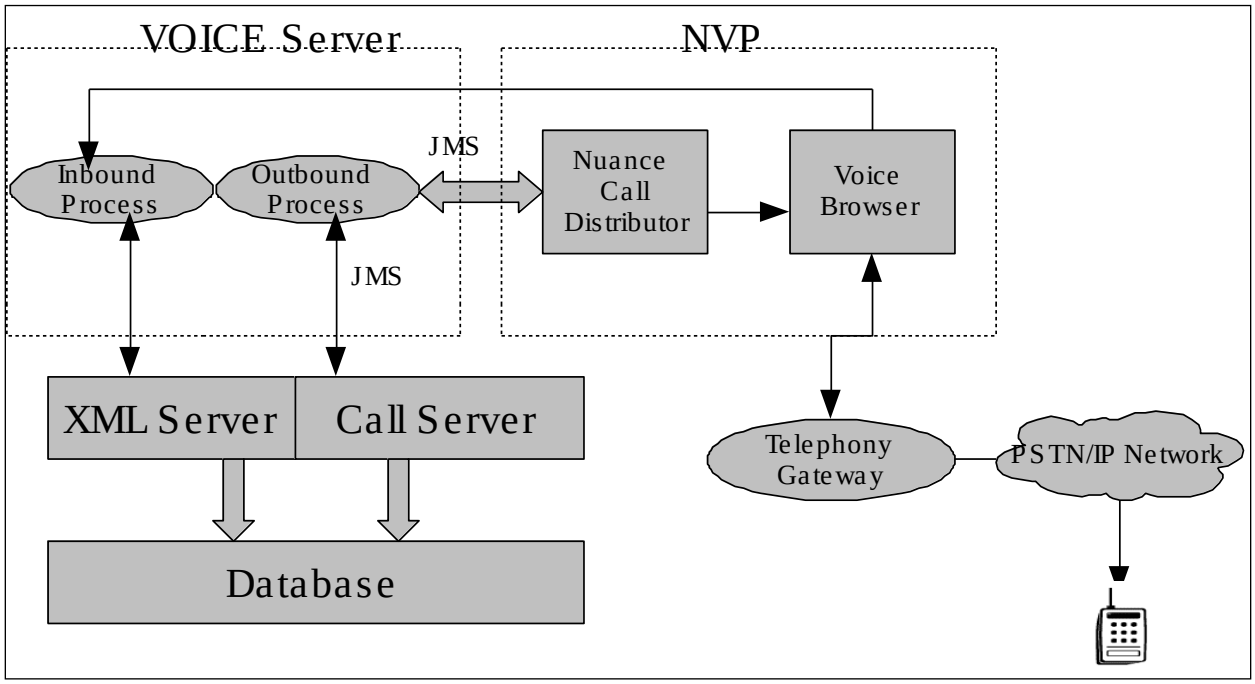


Figure 5. IVR Telephone System Components

5.1.1 Inbound Process

When a truck operator calls the TPLS, the call is processed by Nuance Voice Platform and then handed over to the Inbound process. The Inbound process is a VoiceXML application that interacts with the caller and accepts caller requests such as the location (i.e., area or truck stop/rest area name) for which the caller wants truck parking information. The Inbound process then finds the parking lot information from the backend database and plays the information to the caller (e.g., number of available parking spaces with timestamp and capacity for each location sorted by number of available spaces in descending order). The Inbound process also provides information about amenities available at the specified parking lot. The IVR telephone system will be able to provide updated parking space availability within 30 seconds from when the Data Collection sub-system detects a change in availability.

The caller can request a callback for the desired parking lot or area at a selectable time (15, 30, or 60 minutes later). The Inbound process is responsible for obtaining the calling number and scheduling callbacks.

5.1.2 Outbound Process

The truck operator can request the system to call back with the parking information for a location (area or list of lots) at a certain time. The callback can be set either from the IVR telephone system or public website of the TPLS, although the IVR telephone system is limited to specifying a pre-defined geographic area containing multiple lots or a specific individual lot. The Outbound process is a Java application that is responsible for initiating outbound calls using Nuance Voice Platform (NVP). The Outbound process sends call requests to the Nuance Call Distributor (NCD) using Java Message Service (JMS). The NCD posts the result back to the Outbound process using JMS. If the outbound call attempt is unsuccessful, the Outbound process

will retry the call a configurable number of times (the default is three times). If the call is connected and the called party confirms they want the information, the parking information is played back and the user is placed back at the main menu of the IVR telephone system.

5.1.3 XML Server

The XML Server is the backend process that interfaces with the IVR database. It connects to the database using Java Database Connectivity (JDBC). It gets Extensible Markup Language (XML) requests from the Inbound process over Http. Based on the request, the XML Server invokes Structured Query Language (SQL) stored procedures to retrieve the required response from the database. It then returns the result set of query/stored procedures to the voice system. In case of an error, the XML Server notifies the Inbound process of the error.

5.1.4 Call Server

The Call Server runs a timer thread which checks the database every minute for callback entries. If the timer for an entry in the callback table has expired, the Call Server then places a call request for that stored calling number. In cases of system failures with callback requests in the database, all requests older than a defined threshold will be removed, as the need for the callback will expire after some period of time. The Call Server has a JMS connection to the Outbound process. It sends the callset to a queue. If the call is successful, it updates the callback entry in the database to indicate that the call was successful. If the callback is unsuccessful, it updates the callback entry to call back after a defined period of time, unless that defined number of retries has failed. The Call Server may be a thread or process with the XML Server.

The Java Message Service is a Java Application Programming Interface (API) that allows applications to create, send, receive, and read messages. The Call Server and Outbound process use JMS to communicate with each other JMS producers and consumers are listed below.

Table 4. IVR Call Server and Outbound Process JMS Producers/Consumers

Destination Name	Destination Type	Producer	Consumer	Consumer Type	Message Delivery Mode	Message Expiration Time (default)
CallResultTopic	JMS Topic	Outbound Process	Call Server	Durable	Non-persistent	15 minutes
OutgoingCallQueue	JMS queue	Call Server	Outbound Process			

5.1.5 Nuance Call Distributor

The Nuance Call Distributor (NCD) is the core IVR application that processes and distributes call requests. The call distributor is a JBoss-hosted application that interacts with Nuance Voice Browser services via a dedicated TCP link and with other entities via JMS. It receives callsets via XML JMS text messages that have been sent to a JMS queue by the Outbound process, and posts accumulated results to a JMS topic. The Nuance Voice Browser is a core component of the Nuance Voice Platform that manages both inbound and outbound calls

The Voice Browser service is configured to attempt to connect to a registered NCD at a specified interval. This means that the NCD and Voice Browser service instances can be restarted in any order, or any of these can be restarted at any time, and the Voice Browser service will connect (or reconnect) and register itself as needed. If the NCD is restarted while calls are being made, the Voice Browser service will continue processing the established callset and send any collected results to the call distributor when it is restarted.

The NCD and Outbound process use JMS to communicate with each other. At least one JMS Queue and one JMS Topic are configured for the dedicated use of the outbound dialing application. NCD is configured by default to use queue/CallSetQueue and topic/ResultSetTopic as the Java Naming and Directory Interface (JNDI) names:

Table 5. IVR Nuance Call Distributor and Outbound Process JMS Producers/Consumers

Destination Name	Destination Type	Producer	Consumer	Consumer Type	Message Delivery Mode	Message Expiration Time (default)
ResultSetTopic	JMS Topic	NCD	Outbound Process	Durable	Non-persistent	15 minutes
CallSetQueue	JMS queue	Outbound Process	NCD			

JNDI is a standard Java extension that provides a uniform API for accessing a variety of directory and naming services. In this respect, it is somewhat similar to JDBC. JDBC allows the developer to write code that can access different relational databases such as Oracle, MS SQL Server, or Sybase. JNDI allows the developer to write code that can access different directory and naming services, such as LDAP, Novell Netware NDS, CORBA Naming Service, and proprietary naming services provided by JMS servers.

In JMS, JNDI is used mostly as a naming service to locate administered objects. Administered objects are JMS objects that are created and configured by the system administrator. Administered objects include JMS ConnectionFactory and destination objects like topics and queues.

5.1.6 IVR Telephone System Use Cases

The IVR call-flow diagrams in Appendix D describe the call flows in detail. This section describes the use cases for requesting parking lot information that are as follows.

1. User calls the system and requests parking information
2. User requests a callback from the public website and the system calls the user
3. User requests a callback from the public website or the IVR telephone system and the user calls the system before the scheduled callback time

User calls the system and requests parking information

When a user calls the IVR telephone system without an outstanding callback request, the system lets them know what options are available. The primary option is to find parking. Once they select the option to find parking, the system allows the user to select either a parking lot or a group of lots. The system will then play information on the requested lot(s), and most importantly, the number of available parking spaces.

User requests a callback from the public website and the system calls the user

When a user visits the public website, they will be allowed to request a callback for an individual lot or a user-selected group of lots. They are requested to enter a phone number and a callback date/time. At the requested time, the system will automatically call the user at the specified phone number.

If the call is not answered, the system will schedule a call for five (5) minutes into the future. This rescheduling will happen no more than two times, for a total of three calls (the number of callback attempts is a configurable system-wide parameter). If the call is not answered on the third try, the request will be cancelled.

If the call is answered, the system will ask the user to confirm that they are ready to accept the call to receive parking information. If the user does not respond, usually because the call went to voice mail, the system will ask the question up to three (3) times. If no response is recognized, the system behave as if no answer was received and reschedule the call for five (5) minutes into the future. A call will be rescheduled no more than twice before it is cancelled.

Once a user confirms they are ready, the system will play the information about the requested parking lot(s). After the information plays, the user will be able to select from any of the following options, or simply hang up:

- Repeat: The system will repeat the information.
- Call Me Back: The system will call the user back in 15, 30 or 60 minutes, depending on the user's choice.
- Request Information about Another Lot or Lots. The user says the name of the lot or group of lots, and the system will play information about the requested lot or lots.
- Main Menu: The system will return to the main menu, where the user will be able to select from all available main menu options.

User requests a callback from the public website or the IVR telephone system and the user calls the system before the scheduled callback time

If the user requests that the system call them back, either from the public website or from the IVR telephone system, but they call the system before the requested callback time, the system will immediately play the information for the requested parking lot(s). After the lot information is played, the user will have the same options available as they would if the system called them, or they called the system without an outstanding callback request.

Note that callback request information (i.e., specific parking lot(s) and date/time for the callback request) is shared between the public website and IVR telephone system via a shared database, so that if the user makes a change in one system, those changes will automatically be reflected in the other system. Likewise, if a callback request is terminated by the user in one system, that callback request will automatically be removed from the other system.

There are two primary differences between making a callback request between the public website and IVR telephone system, as follows:

- In the public website, the user can select any set of parking lots for the callback request (up to a configurable limit on the number of lots), but the IVR telephone system will only allow the user to select an individual parking lot or a group of lots based on a pre-defined geographic area. The reason for this difference is that it would be very cumbersome for the user to select multiple individual parking lots for callbacks through the IVR telephone system, thereby contributing to driver distraction.

- In the public website, the user can specify a date and time for when the callback should occur, but in the IVR telephone system, the user can specify that the callback occur in 15, 30, or 60 minutes. Again, this is done to simplify the user's interaction with the IVR telephone system.

Note that the timeframe selected by the user for the callback will apply to all parking lots selected, meaning that separate callback times cannot be specified for each individual lot.

5.1.7 Parking Space Availability Reporting

It is possible to have only partial information about the number of available parking spaces in a parking lot. Since a single in-ground sensor is monitoring a single space, the system has to be able to handle failures on one or more sensors. For this situation, the strategy is to report the number of known available parking spaces, but also indicate that more spaces might be available. This is accomplished through the use of the phrase "at least" when announcing or displaying the number of available spaces. The following are the rules employed for space reporting:

- If there are one (1) or more available spaces, and 0 unknown spaces for a parking lot, the IVR telephone system will report "There are x available spaces".

- If there are one (1) or more available spaces and one (1) or more unknown spaces for a parking lot , the IVR telephone system will report "There are *at least* x available spaces".

- If there are 0 available spaces for a parking lot, regardless of how many unknown spaces there are, the IVR telephone system will report "There are NO available spaces".

- If all the spaces for a parking lot are unknown, or all of data collection is down, the IVR telephone system will report "The number of spaces is unavailable".

5.1.8 Database Tables

The database tables for the IVR telephone system are described in Section 6.1, Database Tables.

5.1.9 IVR Telephone System Parameters

The following parameters are used by the IVR telephone system.

- Callback Retries – Contains the number of retries the system will attempt if the recipient of the callback does not answer and confirm. Default is 3.
- Callback Retry Wait Time – Contains the amount of time the system will wait between retries when the callback is not successful. Default is 5 minutes.

5.2 Public Website

The I-95 TPLS website is divided into three layers to provide for ease of development, on-going maintenance, and scalability (including the ability to support up to 100 concurrent users).

The **Pages/Views Layer** provides the HTML pages presented to site visitors, allowing them to view both static and dynamic content. Visitors enter information through these pages (e.g., callback requests).

The **Modules Layer** provides the logic behind the pages in order to make the site interactive and responsive to visitor-specific requests. Javascript and .NET are used to provide the necessary logic.

The Database Layer provides the connectivity necessary to retrieve and write data from/to the databases containing parking space availability, lot information, and user profiles.

These layers are shown in Figure 6, below.

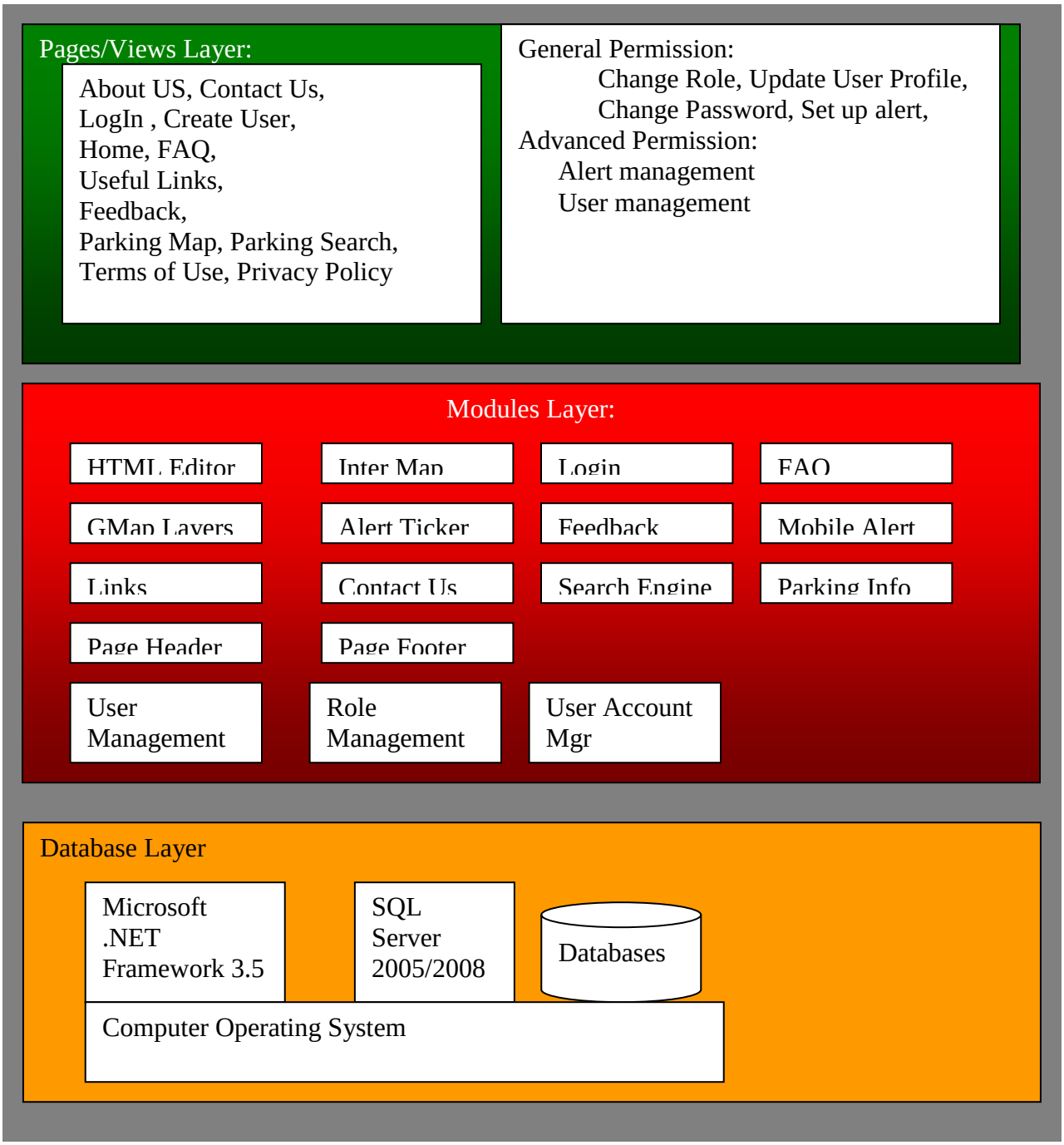


Figure 6. Public Website Layers

5.2.1 System Inputs

System inputs will come from three key sources: TPLS Data Collection sub-system, Google Maps, and system subscribers.

All data related to parking facilities (i.e., name, location, amenities, number of spaces available) will be retrieved from the TPLS database using MS SQL Server stored procedures. The website will read the database in real-time whenever the user queries the system for facility information. This will ensure visitors are provided with the most up-to-date information for each facility. Updated parking space availability information will be provided within 30 seconds from when the Data Collection Subsystem detects a change in availability.

The Google Maps API will be used to merge parking facility data to geographically present the information to site visitors.

Subscribers will provide their information for account setup and their specific "Call Me" requests.

5.2.2 System Outputs

They key output from the website will be "Call Me" requests submitted by subscribers. These requests will be written to the database in order for the IVR telephone system to access and fulfill the requests.

5.2.3 Supported URL's

The Coalition has reserved the domain names of "www.TRUCKNPARK.COM" and "www.I95TRUCKPARKING.COM". If desired, additional domain names can be reserved and automatically directed to either of the reserved domain names.

5.2.4 Supported Browsers

Two browsers will be supported: Internet Explorer (Versions 6, 7, 8, and 9) and Firefox (Version 21). All development and testing will be centered on these two browsers.

5.2.5 Mobile Device Support

Given the hazards of navigating a website while driving, the TPLS website will not support any mobile devices. Instead, a mobile device redirect will be implemented where the site will examine all HTTP requests and determine if the request is coming from a mobile browser. If a mobile browser is detected, the requestor will be redirected to a page explaining the policy.

5.2.6 User Account Management

Though the website will be open to the general public, the "Call Me" feature will only be available to TPLS subscribers. Subscriptions will require a mobile phone number, password, e-mail address, and security question/answer pair. The mobile phone number will be used as the unique identifier for the account and serve as the phone number to be called for callback requests initiated through the website. Once the user's account has been established, the user will need to supply his/her phone number and password to subsequently login to the "Call Me" function. No personal or financial information will be requested. See Figure 7, below, for a sample screen.

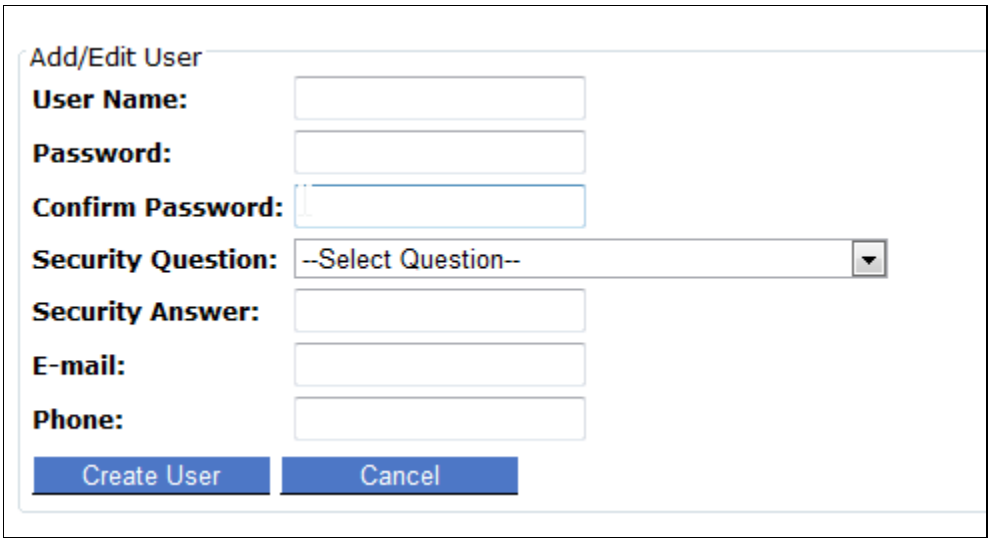


Figure 7. Website Login

Users will also have the ability to delete their "Call Me" account from the website after they login to the account.

Passwords will be stored in encrypted form to ensure no one with access to the database can gain access to a subscriber's account. If subscribers should ever forget their password, they will be able to set a new password by providing the answer to the security question they selected during account setup.

A separate System Administrator profile will be established allowing for authorized users with that profile to post, edit, and remove alert messages, reset subscriber passwords, and remove accounts. Additional information is provided in Section 7.2 regarding website administration functions.

5.2.7 User Interface

5.2.7.1 Home Page

Using the Microsoft .NET development platform, an intuitive user interface will be developed. From the home page, site visitors will be able to navigate quickly to pages of interest and by providing a navigation bar, visitors will be able to move to most other pages using a single click. See Figure 8, below, to view the home page.

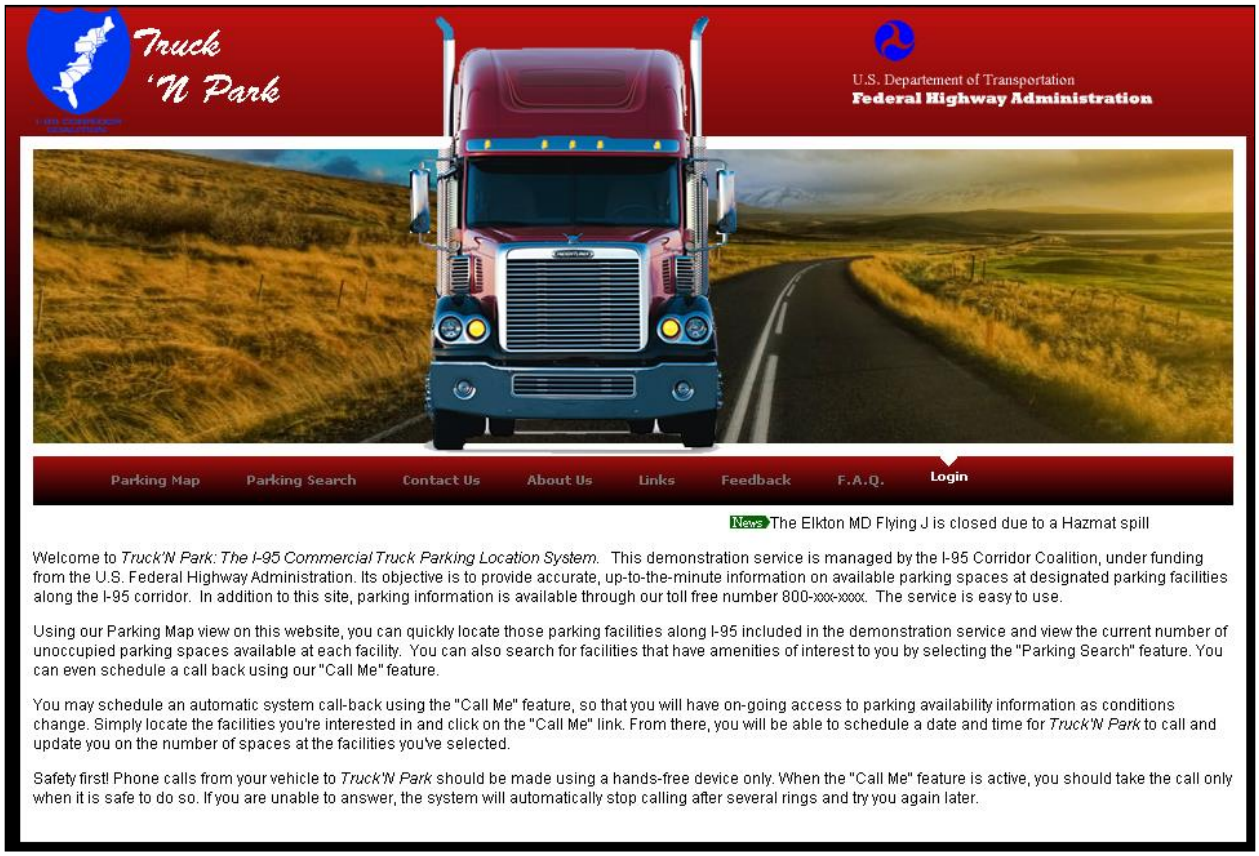


Figure 8. Website Home Page

The home page will provide introductory information as well as access to all functionality available through the website. In addition, the home page will include the capability to display a horizontally scrolling "alert" message below the main graphic containing critical information, such as a disruption to a specific parking area.

All information in the website will be provided in English.

5.2.7.2 Parking Map

The Parking Map will enable visitors to graphically view the locations of all the facilities in the system and the number of spaces available at each site. See Figure 9, below, to view the parking map.

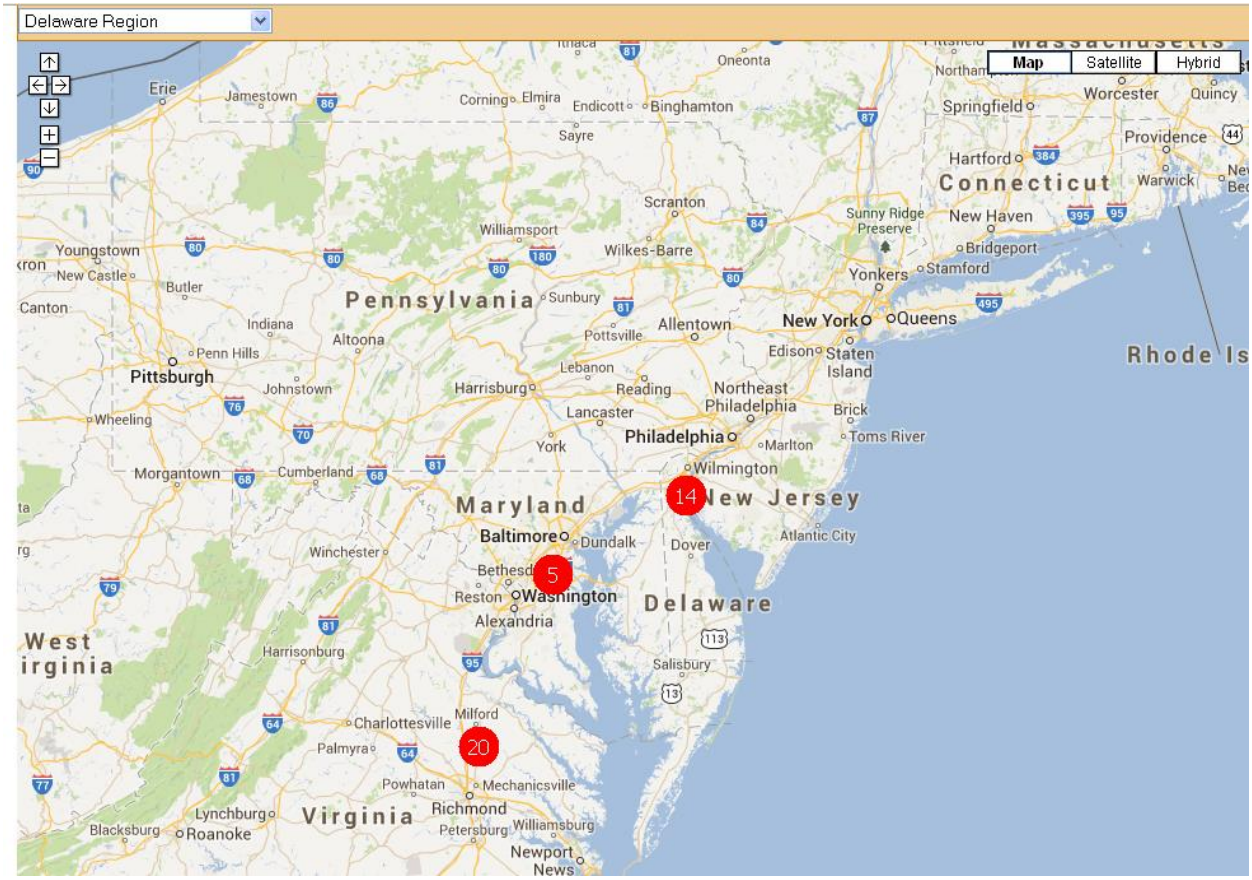


Figure 9. Website Coverage Map

Parking Map features will include:

1. Visitors will be able to pan the map along with zooming in and out.
2. A drop-down list will allow zooming to an area of interest in a single action.
3. Icons will represent parking facilities along with embedded available space counts.
4. Tool-tip will be available when the cursor hovers over a facility icon that will display facility name and location.
5. Clicking on a facility icon will invoke an information box providing details for the specific facility. See Figure 10, below. This information box will also provide a means to link to the "Call Me" feature and to Google Maps for directions to the facility.

Figure 10. Website Sample Facility

It is possible to have only partial information about the number of available parking spaces in a parking lot. Since a single in-ground sensor is monitoring a single space, the system has to be able to handle failures on one or more sensors. For this situation, the strategy is to report the number of known available parking spaces, but also indicate that more spaces might be available. This is accomplished through the use of the phrase "at least" when displaying the number of available spaces. The following are the rules employed for space reporting:

- If there are one (1) or more available spaces, and 0 unknown spaces for a parking lot, the public website will show "Available Parking Spaces: xx".

- If there are one (1) or more available spaces and one (1) or more unknown spaces for a parking lot , the public website will show "Available Parking Spaces: *At least* xx".

- If there are 0 available spaces for a parking lot, regardless of how many unknown spaces there are, the public website will show "Available Parking Spaces: 0".

- If all the spaces for a parking lot are unknown, or all of data collection is down, the public website will show "Available Parking Spaces: Unavailable".

Parking lots with an unknown number of available parking spaces will be indicated with a special color on the main parking lot map and shown as "?". For facilities with one or more unavailable sensors, the parking lot map will show the number of available spaces with a plus indicator; for example, when there are at least five (5) available spaces for a particular parking lot, it will appear as "5+" on the map.

6. Clicking on a Parking Facility Area will invoke an information box displaying information for all of the facilities within the area. See Figure 11, below. Within that box, the user can setup a callback request for individual parking lots and click on the parking lot name to view all detailed information for a specific lot.
7. The map will refresh at a configurable rate (initial default rate is five minutes) so as to update parking space availability as new data becomes available from the field.

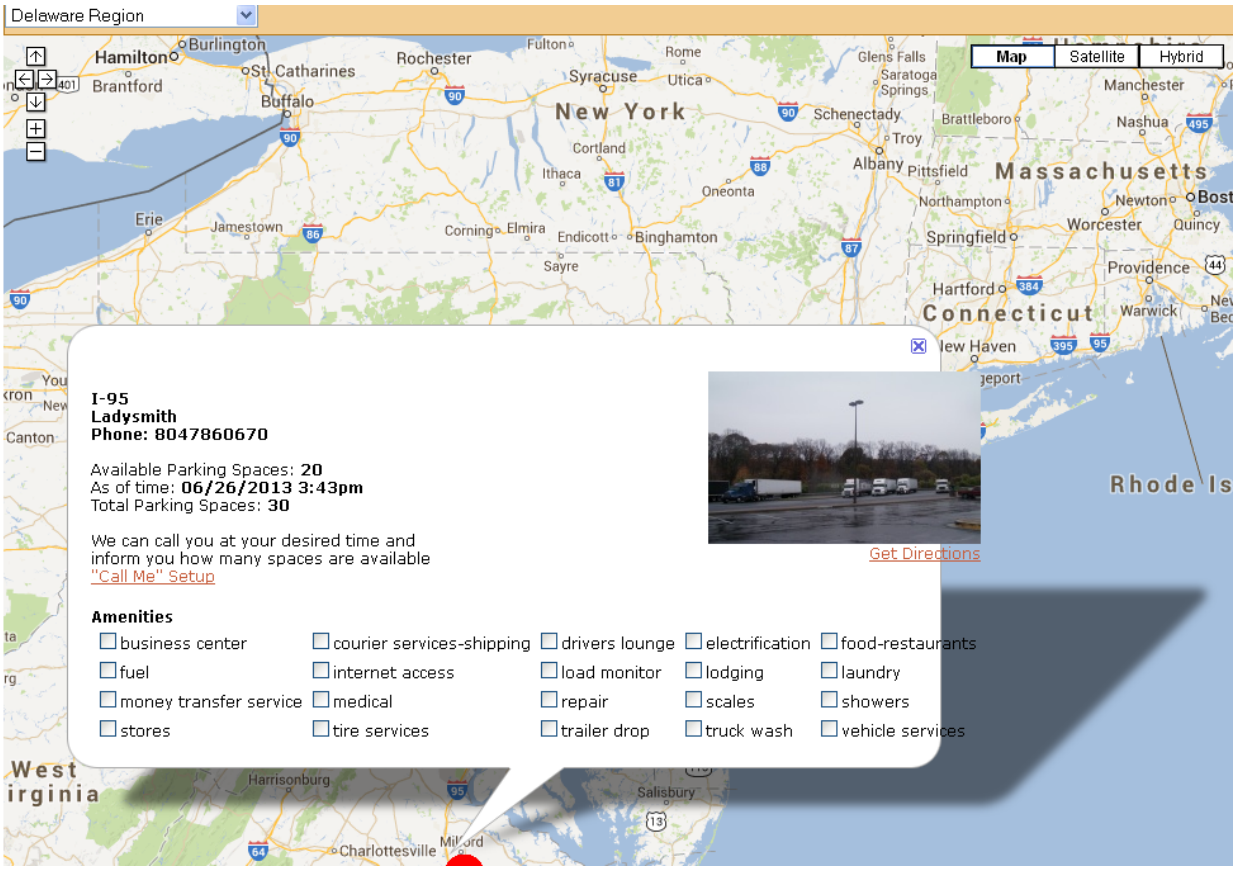


Figure 11. Website Multi-Facility Information Page

5.2.7.3 Parking Search

In addition to the map, visitors will be able to perform searches for facilities using the "Parking Search" feature. Visitors will be able to search by area and amenities as filters. See Figure 12, below.

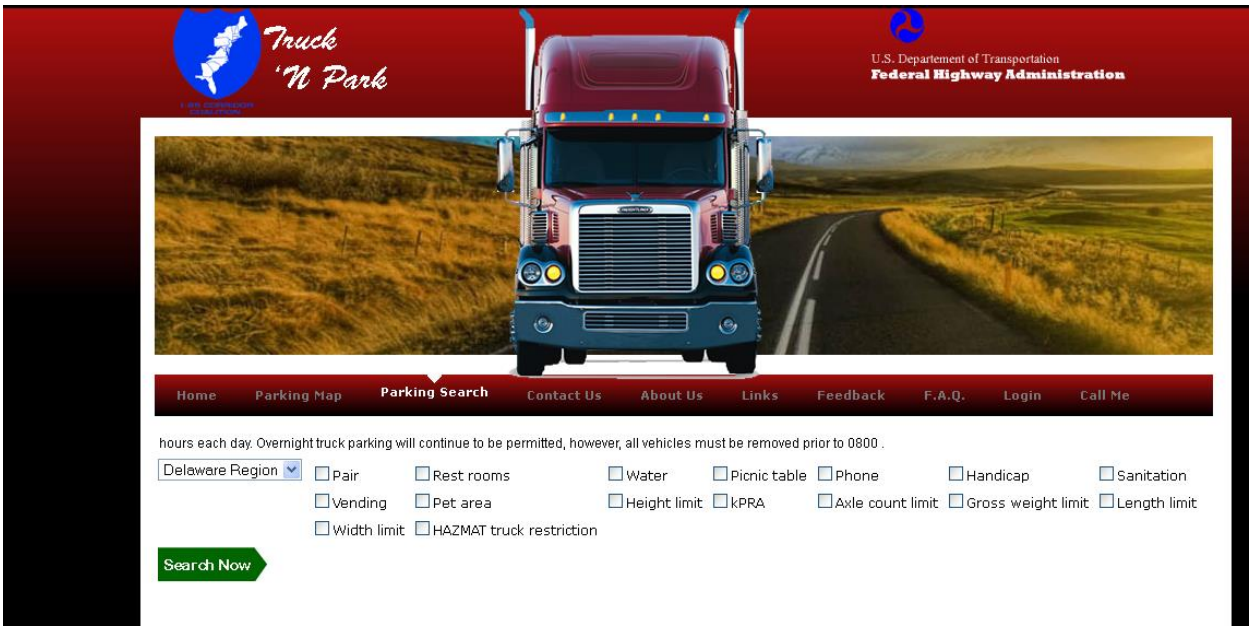


Figure 12. Website Parking Search

5.2.7.4 Call Me

Subscribers will be able to enter requests for callbacks from the IVR telephone system. Subscribers can access this feature through the Login function on the home page as well as the Parking Map and Parking Search pages. To login, the user will enter his/her mobile phone number and account password that was supplied when the account was established. The "Call Me" setup page (see Figure 13, below) will appear and allow subscribers to select up to six facilities from one or more areas for a callback at one specific date and time for all callbacks. This number is a configurable parameter. Callback requests can be made up to 48 hours in advance. Once a subscriber has submitted a callback request, they will not be permitted to request an additional request until their existing request has either expired or been deleted. They will be permitted to edit an existing request by either adding or removing facilities and altering the callback date/time. See Section 5.1.6, IVR Telephone System Use Cases, for additional information related to callbacks on the IVR telephone system.

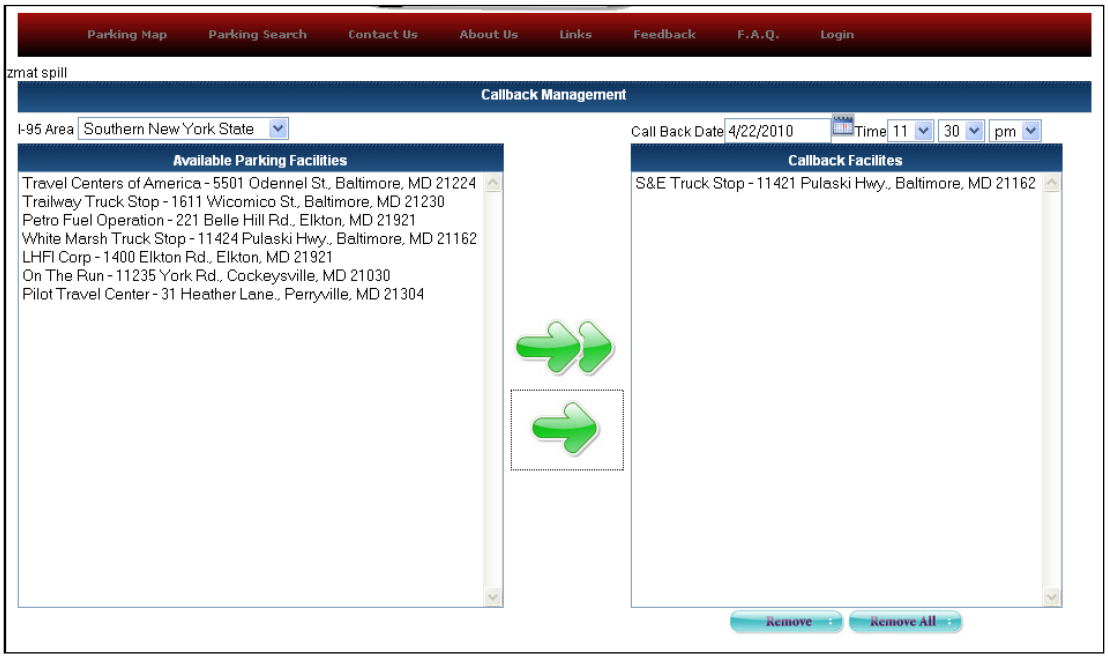


Figure 13. Website Callback Management

5.2.7.5 Links

In order to provide comprehensive traveler information for the I-95 corridor, links to various 511 websites for corridor states will be included on the Links page. For states that do not have a 511 website, a link to the state's traffic information page will be used instead.

5.2.7.6 Feedback

A form will be provided allowing visitors to the site to leave feedback regarding their experiences on the website. Feedback information will be stored in a database for subsequent reporting and analysis by System Administration staff. In order to promote participation, the number of questions will be left to a minimum. A sample Feedback page is shown in Figure 14, below.

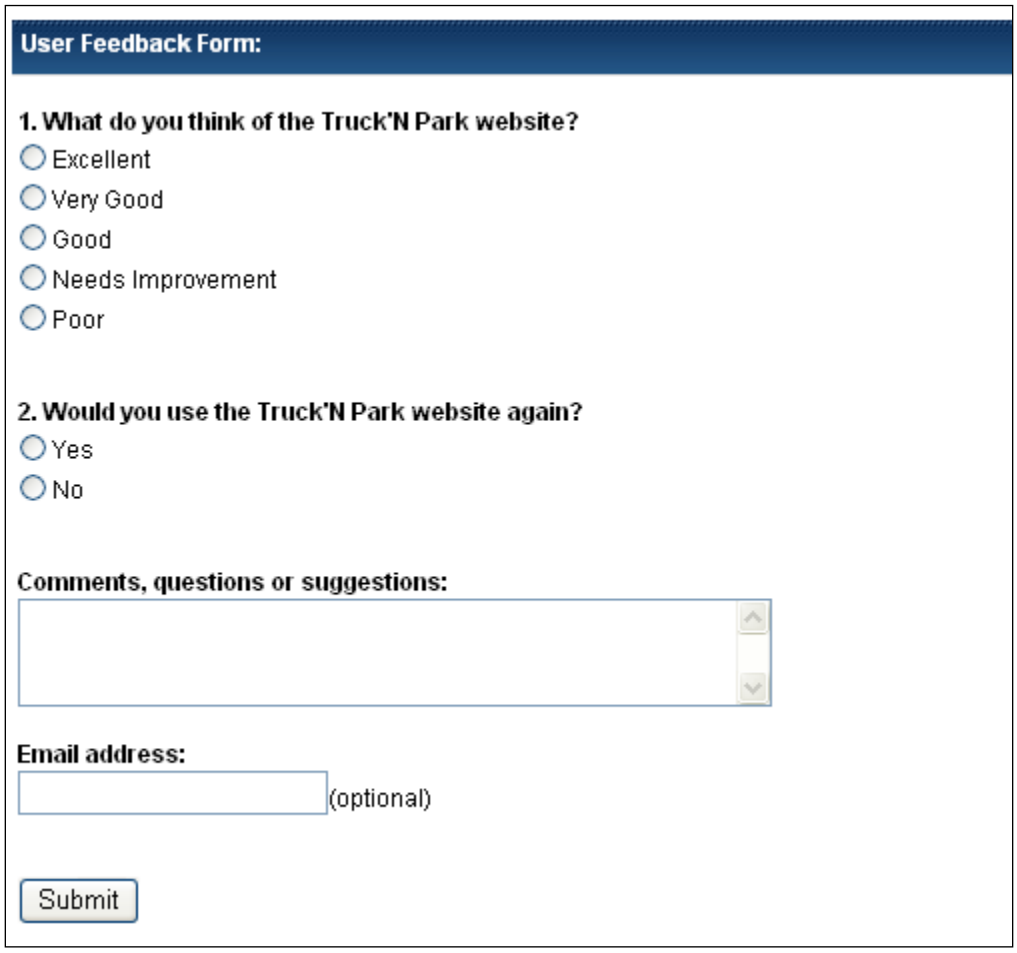


Figure 14. Website User Feedback

5.2.7.7 Contact Us

A "Contact Us" page will be available that provides an e-mail address for users to submit questions related to the Truck Parking Location System.

5.2.7.8 Frequently Asked Questions (FAQ's)

The website will include online help information in the form of a Frequently Asked Questions (FAQ) section. Questions and answers will be provided explaining usage of the website and IVR telephone system. The FAQ's will be stored in an Adobe PDF file and displayed on the screen when the FAQ function is accessed. System Administration staff will be able to update the FAQ file as new or updated information becomes available.

5.2.7.9 About

An "About" page will provide a brief overview of the Truck Parking Location System as well as a privacy statement discussing how the information collected by the website will be used and a terms of use statement describing how information gathered at the website may be used.

5.2.7.10 Section 508 Compliance

In order to ensure the TPLS public website is accessible to all, all source code will be written to comply with Section 508 of the Rehabilitation Act using coding standards published by the World Wide Web Consortium (W3C). Compliance with the standard will be validated using the Total Validator tool.

5.3 External Data Feed

The I-95 Truck Parking Location System includes a Parking Data Export (PDE) application to periodically export parking lot space availability data contained in the system database for all parking lots to an XML file and make this information available to outside applications. This information may be useful to transportation department agencies and information service providers desiring to compile statistical information for further dissemination and various tracking or reporting activities.

The exported XML file is placed in the directory specified in the application's properties file. This application creates one file containing data for all of the parking lot sites designated for export. The application runs as a background Windows Service with no application window. As such, it starts automatically when the server on which it resides powers up. This application publishes the parking lot data at an interval specified in the application's properties file. By default, it runs every completed poll cycle. Running as a Windows Service, it accomplishes this without any operator intervention. As long as the server is up, data is collected and an export file is created.

The XML file will be stored as a text file in a location available to external systems.

5.3.1 Properties File

The Parking Data Export Application uses a properties file to get parameters needed to run. The file must include the parameters defined in Table 6, below.

Table 6. Parking Data Export Application Properties File Parameters

Parameter Name	Description	Format
DBUserName	Valid name for logging into the TPLS database	Alpha-numeric
DBUrl	A URL denoting the TPLS database name and database machine name	Alpha-numeric
ExportDir	Network directory where the exported file is written. If omitted, the file is written to the current directory.	[drive:][path]
FileExtension	Filename extension for the export file	Alpha-numeric (default – txt)
FileFormat	Name of the template XML file used to generate the final XML file.	[drive:][path][filename]

Parameter Name	Description	Format
LogKeepDays	The retention period for old log files	Numeric
ExportTimerIntervalInMinutes	Timer interval for writing the export file	Numeric
ZipArchivedExportFiles	Flag to indicate if archived files should be zipped	Numeric
ArchiveZipFileName	Prefix for the archived zip file	Alpha-numeric
ArchiveExportDir	Network directory where archived files are written. If omitted, files are written to the current directory.	[drive:][path]
ArchiveFileKeepDays	The retention period for old archived files	Numeric

The internal database user account should have *SELECT* privileges but not *UPDATE* or *INSERT* privileges on the Data Collection tables listed in Appendix C.

Although a user password is needed to log into the database, none is specified in the properties file. It is required that the user account created to execute this application has a password that matches the user ID.

5.3.2 Export File Name

The export file will contain data for all the parking lots tagged for export in the tblGeoPointInfo table. The file name is the string *ParkingLot*. The file name extension is set to the value of the *FileExtension* parameter in the properties file or to *txt* when the parameter is not specified. So, an example of the parking data export file name would be: ParkingLot.xml.

5.3.3 Logging

The Parking Data Export application maintains a log file of significant events. Records are included in the log for the following events:

- Application logs into the database
- Application logs out from the database
- An export file is created for one or more parking lots
- Operational errors in the application
- The application goes dormant
- The application terminates
- An export file is deleted
- A log file is deleted

When the application begins execution or when transitioning from dormant to active, it examines existing log files. Log files are deleted if their dates are beyond the retention period specified by the *LogKeepDays* parameter in the properties file.

5.3.4 Exported File

The Data Collection process creates an XML file containing parking lot data collected at a specified interval. The file format is a customization of an industry ATIS standard; see Appendix E for an example of output.

6 System Data

This section describes the details of system data, including database tables and inter-system flow.

6.1 Database Tables

The I-95 Truck Parking Location System uses MS SQL Server as its database server. Some tables are only used by one subsystem, and others are shared between subsystems. Most of the IVR telephone system and public website tables are shared. The tables within the IVR telephone system customized for truck parking and public website components are described below. Database tables specific to data collection are provided in Section 5, Common System Tables. Appendix C provides entity relationship diagrams defining the relationship between the various database tables.

6.1.1 IVR Telephone System Database Tables

The tables specific to the IVR Telephone System are described below.

6.1.1.1 tblPointOfInterest

This table contains the information of all the points of interest (POI) in all states. The point of interest can be a city name, landmark, rest area, etc. This is an existing table in the base IVR telephone system software being customized for the truck parking application. Two new POIType values (ParkingArea and ParkingLot) will be added.

Column Name	Type	Description
POIIdx	Nvarchar(24) NOT NULL	Primary key for the table
POIName	nvarchar(128) NOT NULL	Name of the point of interest
POIDisplayName	nvarchar(128)	Public facing name of the point of interest
POIType	Nvarchar(24) NOT NULL	Type of POI. It can be a city, landmark, rest area, etc.
DrivingTimeNodeID	int	Not used for Truck Parking
RoadName1	varchar(128)	Not used for Truck Parking
RoadName2	varchar(128)	Not used for Truck Parking
POIGrammar	Nvarchar(1024)	Grammar used to recognize the POI Name
POIWavFileName	Nvarchar(128)	A voice file that plays the name of the POI
DTMFTone	int	DTMF Tone associated with the POI

6.1.1.2 tblPkgLotToPOI

This table associates points-of-interest with parking lots. A single point-of-interest can be associated with multiple parking lots and vice-versa. Also, the table identifies the proximity of the parking lot to the point-of-interest.

Column Name	Type	Description
NodeID	Nvarchar(32) NOT NULL	Unique ID from the table tblGeoPointInfo
POIIdx	Nvarchar(24) NOT NULL	Unique ID for the POI
Distance	float	Distance in miles from POI to parking lot
id	Int NOT NULL	Primary key for the table. It is an auto increment value.

6.1.1.3 tblPkgCallback

When a truck operator sets a callback, that information is stored in this table. This table stores the retries, start time of the callback, and the calling number of the user.

Column Name	Type	Description
CallbackNumber	Nvarchar(24) NOT NULL	Phone number to call back. Primary key
CallbackTime	datetime	Date/time when the system should initiate the callback
Retries	Int	Actual number of callback attempts

6.1.1.4 tblCallbacktoPOI

This table stores the list of parking lots/areas for the callback number. Callbacks can be requested for multiple parking lots.

Column Name	Type	Description
CallbackNumber	Nvarchar(24) NOT NULL	Phone number to call back. Primary key
POIIdx	Nvarchar(24)	Index of the lot to call back about

6.1.1.5 tblLocationType

This table stores the list of valid POI types. For Tier I, the system will implement POI types of Parking Region (such as Baltimore and New York) and Parking Lot.

Column Name	Type	Description
LocationTypeID	Int NOT NULL	Primary Key - Unique ID for the POI Type
LocationType	Nvarchar(24) NOT NULL	Name of the POI Type
Grammar	varchar(512)	Grammar for IVR recognition

6.1.2 Public Website Database Tables

A graphical view of the database schema for the public website is provided in Appendix C. This schema includes all the tables needed to manage user accounts (both users and administrators) and manage ticker messages on the public website.

7 System Management and Operations

This section provides information on administration and operation of the I-95 Truck Parking Location System.

7.1 Data Feed Administration and Monitoring

The TPLS data feed from the instrumented parking areas will be updated every two (2) minutes to maintain timely parking space availability information. Information will be collected, validated, and integrated for dissemination to the end user through the public website component, the IVR telephone system component, and the Parking Data Export application. The secure data-collection user interface also provides the ability to monitor the status of each camera feeding video snapshots and parking availability data into the central system. Should the need arise, the data-collection user interface also provides the capability to manually override a system-generated data value. If there is a clear, known issue with the data accuracy, such as a truck parking sideways across several parking spaces and confusing the available spaces count, the operator can set an offset in the system.

Likewise if a parking space or series of parking spaces are unusable, such as if a portion of the parking lot is being re-striped or re-paved, the operator has the ability to designate specific spaces as unavailable, to modify the total number of available parking spaces for a particular lot.

7.1.1 Sensys Sensor Replacement

In the event that a Sensys Networks sensor detection device needs to be replaced in the field, it can be removed and a replacement device mounted in its place. The device can then be configured remotely through the TrafficDOT software provided by Sensys Networks to make it easier for the TPLS operator to get the parking lot fully back up and running more quickly.

7.2 Website Administration and Monitoring

The TPLS public website will include administrative pages that can only be accessed by users with the appropriate access authority. Such access will be protected by User ID and password. These pages will include “Ticker Message Management,” “Lot/Parking Info,” “User Account Management,”, “User Feedback Reporting”, and “Applications.” Each of these pages is described in the sections below.

7.2.1 Ticker Message Management

The website provides a means of broadcasting messages to all visitors to the site via a “ticker” message that will scroll across all the pages on the site. An administrator with the proper access will be able to add, edit, and remove ticker messages, as shown in Figure 15, below.

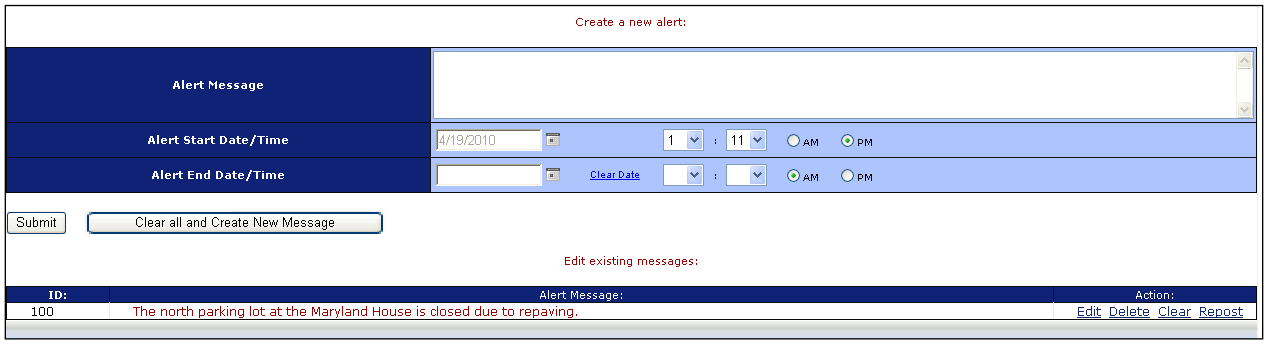


Figure 15. Ticker Message Management

7.2.2 Parking Lot and Space Information

The website will allow system administrators to view the current configuration of parking lots and spaces. The following functions will be available to administrators:

- View the number of total spaces, available spaces, occupied spaces, unknown spaces, and those spaces that have been marked as offline.
- View and edit the amenities associated with each parking lot
- View the detectors that have been configured for each space in each lot and the status of each detector. Administrators can mark detectors as online or offline.
- View the actual parking lot through periodic snapshots and streaming video from cameras installed in the lot. The page will also link to a website that will allow camera configuration changes, if the selected camera has that feature.
- View one or more static, annotated graphical images that depicts where the detectors, cameras, and other devices are installed in the parking lots.
- View the devices that have been installed in the system. For those devices with administration software tools installed, the administrators will be able to link to them.

A sample screen with this information is shown in Figure 16, below.

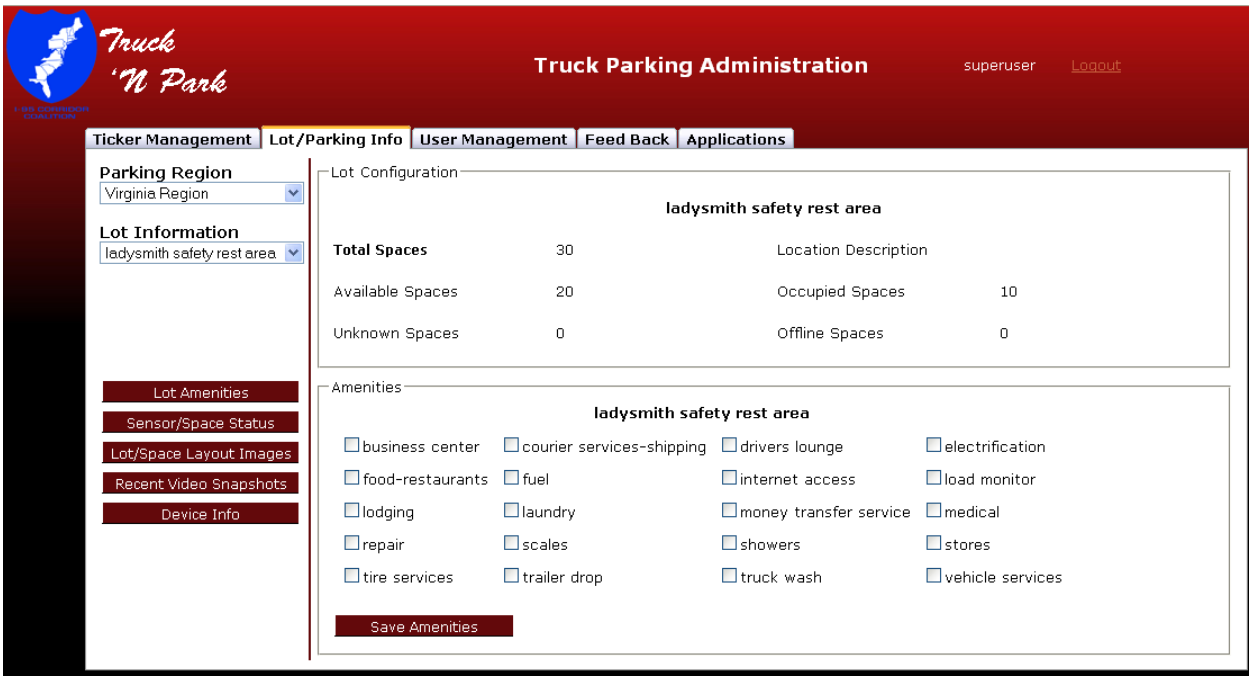


Figure 16. Lot/Parking Information

The user will initially select a parking region (e.g., Maryland, Virginia, Delaware) of interest, and then select a parking lot from the list of lots in the selected region. The top part of the screen will show the following statistics for the selected parking lot.

1. Location Description: A description of the parking lot
2. Total Spaces: Total spaces in the lot (note: adding available, occupied, unknown and offline should equal total)
3. Available Spaces: Total spaces available in the lot
4. Occupied Spaces: Total occupied spaces in the lot
5. Unknown Spaces: Total spaces for which there is no status
6. Offline Spaces: Total spaces in the lot that are marked as offline

Five clickable buttons will be available on the left side of the screen, as follows.

1. Lot Amenities: The current set of amenities in the system configuration will be displayed in the lower half of the window, with the ability for the system administrator to select and de-select amenities for the parking lot.
2. Sensor/Space Status: See below for details.
3. Lot/Space Layout Images: See below for details.
4. Recent Video Snapshots: See below for details.
5. Device Info: See below for details

<u>Sensor/Space Status Button</u>

In the lower window, a scrollable list of all sensors/spaces in the parking lot will be displayed in a tabular format. Each sensor row will have the following columns.

1. Space ID
2. Sensor ID
3. Online/Offline Status
4. Space Status (only filled if space is online): Values are Available, Occupied, Unknown
5. Camera ID – The ID of the camera that has the best view of the space
6. Camera Preset ID: The preset ID of the camera that has the best view of the space
7. Online/Offline Change button: Toggles a space between online or offline mode. This will automatically update (1) the Online/Offline cell for that row, (2) the Space Status cell for that row, and (3) the space counts in the top part of the window (only Available, Occupied, Unknown, and Offline should be affected)
8. View Snapshot button: Opens a new window to show the most recent snapshot of the space, with the following additional information to allow selection of other snapshots for the space to be viewed:
   a. Calendar widget to allow date selection: Defaults to the day associated with the most recent snapshot (should generally be current date)
   b. Drop down with a list of 24 hours of a day: Defaults to the hour associated with the most recent snapshot (should generally be current hour)
   c. Dropdown list with a list of the times of all available snapshots for the selected hour and date for the selected space in descending order: Defaults to the most recent, with the status (Available, Occupied, Unknown, Offline) of the selected space closest to the time of the snapshot.
9. View Streaming Video button: Opens a new window with the URL of the corresponding camera

The table will initially be sorted in ascending order by Space ID. Column headers can be clicked to sort by the particular column (first click is ascending order, second click is descending order). A sample screen is shown below.

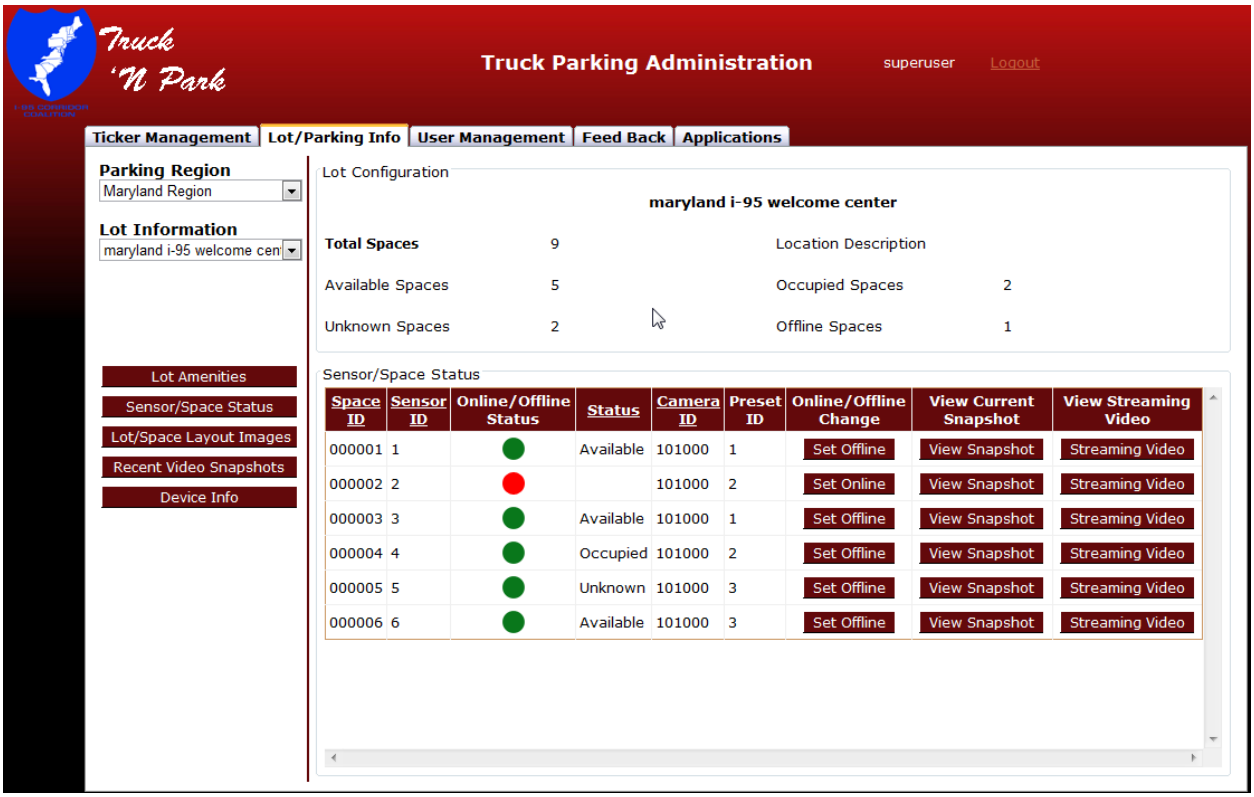


Figure 17. Sensor/Space Status Information

Lot/Space Layout Images Button

Opens a new window with all static annotated images associated with the lot, and a caption for each. This window will be scrollable if necessary.

Recent Video Snapshots Button

Opens a new window with all of the recent snapshots for all cameras in the lot with a caption/title for each. Each caption/title may include the Timestamp, Camera ID, and Camera Preset ID. This will include every preset for every camera on the lot sorted by Timestamp, Camera ID, and Camera Preset ID. This window will be scrollable if necessary.

Device Info Button

Displays a dropdown where a device type is selected in the lower half of the window. Once a device type is selected, a list of all devices of the selected type will be displayed with the following: Device ID and a Configure button, sorted by Device ID in ascending order. The Configure button will open a new window with the URL of the device configuration. If the device is a camera, the following additional buttons will also be included.

a. View Current Snapshots: Opens a new window to view the most recent snapshots for every preset of the selected camera
b. View Streaming Video: Opens a new window with the streaming video URL for the selected camera

A sample screen is shown below.

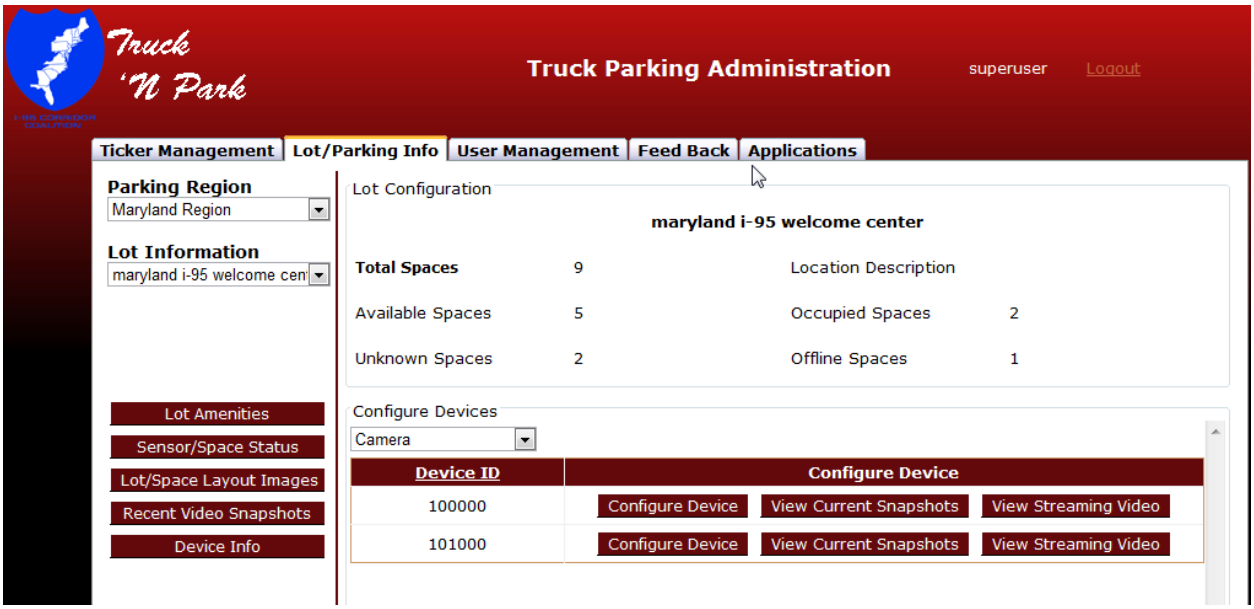


Figure 18. Device Information

7.2.3 User Account Management

System administrators will be able to manage website accounts using the User Management page. On this page, administrators will be able to create and delete accounts, change passwords, and update access rights. All users will have the same access rights, i.e., to create and update their own callbacks and to update their passwords.

7.2.4 Feedback Reporting

So that the feedback left by website visitors can be viewed by system administrators, a Feedback page will be provided, as shown in Figure 19, below. The report will provide summary data for all survey questions and a detailed listing of user comments. Date filters will allow for viewing feedback statistics and comments for a particular date range.

After viewing a comment from a user, the system administrator can delete the comment if so chosen.

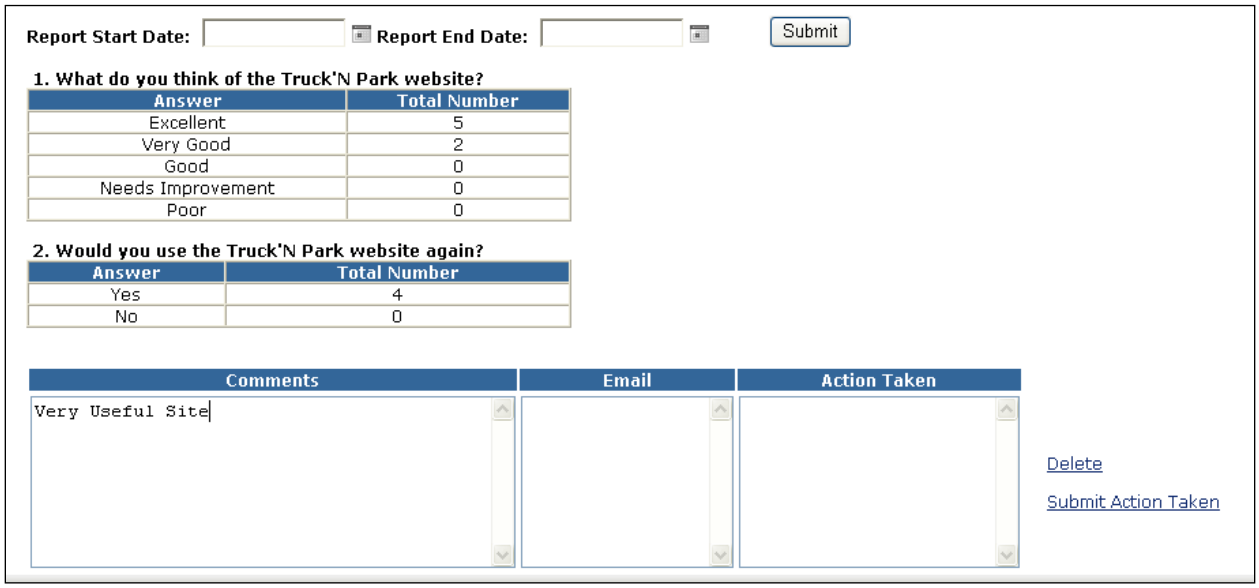


Figure 19. Feedback Reporting

7.2.5 Usage Reporting

An open source product managed by Sourceforge, called AWStats, will be used to provide usage data for the public website. AWStats can provide usage statistics for any reporting period desired. Available statistics include: total visits, total page views, total hits, and highest volume day. See Figure 20, below, for a portion of a sample report.

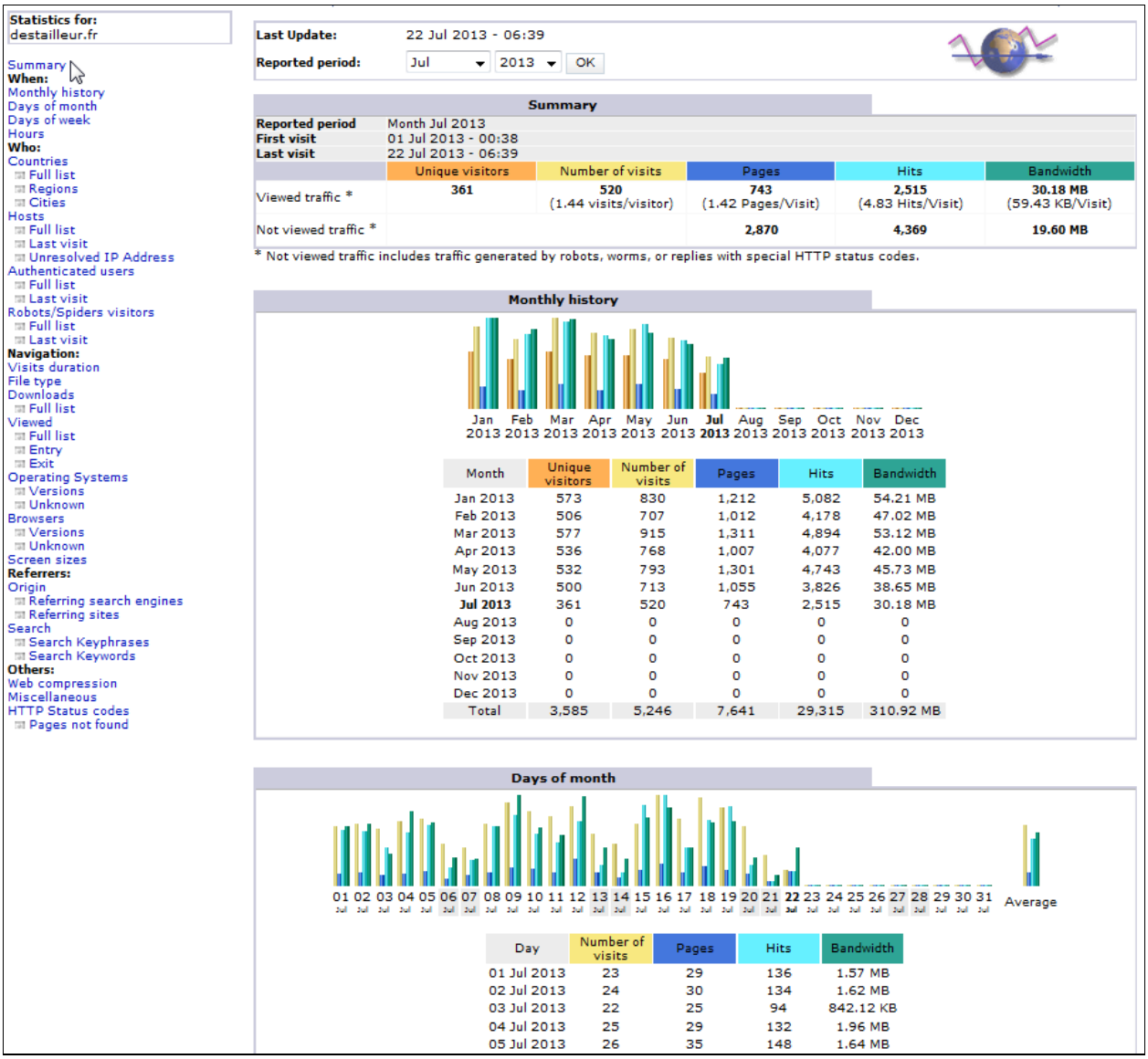


Figure 20. Public Website Usage Reporting

7.2.6 Access to Support Applications

The "Applications" tab on the TPLS Administration Website will provide system administrators with easy, one-stop access (via a link) to various TPLS administrative applications, which may include:

- ApexSQL
- AWStats
- IVR Manager
- What's Up Gold
- Trouble ticket reporting system

Field equipment applications may include:

- Camera control/monitoring
- Access point/repeater configuration
- Modem configuration
- UPS configuration
- Sensor configuration – SNAPS, TrafficDOT

7.3 IVR Telephone System Administration, Monitoring, and Usage Reporting

The IVR telephone system will include tools for managing comments and producing usage reports.

The IVR Manager is a web-based tool for managing specified components of the IVR system. Users are required to have a valid login and password to access the IVR Manager tool. The IVR Manager includes a feature for managing caller comments. If user comments are received, they will be displayed in a Manage Comments page within the IVR Manager. System managers will be able to listen to, download, delete and/or store all comments in a set of folders that they can manage. System Administrators will have the ability to set the maximum comment duration. The default duration is two minutes. The IVR Manager also contains features to manage system recordings used by the IVR telephone system. Authorized users can listen to, upload, download, delete, search on, and organize system recordings. A complete User Guide for the IVR Manager will be available for the project.

An online reporting tool, ApexSQL Reports, will be available for users to generate various usage reports for the IVR telephone system. Users will need a valid username and password to gain access to the tool. For each report, users will be prompted for a date range to produce reports with the following types of information:

- Total Calls,
- Average Call Duration,
- Total Unique Callers,
- Peak Calling Period,
- Frequently Requested Parking Locations.

From the tool, users will be able to download the reports into an MS Excel spreadsheet, a PDF file, or an XML file.

7.4 Video Display System

The Data-Collection module of the TPLS will include a capability to visually monitor and verify the number of truck parking spaces available within an instrumented lot. This feature will only be accessible to authorized operations staff via a user ID and password login. See Section 7.2.2, Parking Lot and Space Information, for additional information.

A complement of Siqura PTZ cameras will be installed at each parking facility with live camera snapshots automatically sent to the central system on a periodic basis (e.g., every minute) to provide visual inspection capability. With these Siqura PTZ cameras, a trained operator will be able to visually monitor the available truck parking spaces using the TPLS Administration site to select multiple simultaneous live camera feed snapshots. The Siqura video feeds can be used for an inspection of the parking area so that the available space count can be verified.

The camera vendor will provide an application that periodically captures the camera snapshot and sends it to the appropriate TPLS server. For locations that require camera tours to cover larger areas, the application will first re-position to a camera preset on the tour and then capture/send the snapshot. It will then re-position to the next preset and capture/send the snapshot, and repeat this process so that camera snapshots for the entire area are provided within the timeframe configured for the system. So, for example, if a snapshot of each area is needed every minute, and a camera tour with three presets is needed to cover the area, the application will go to each preset and capture/send the snapshot every 20 seconds.

Operations staff will also have access to the Siqura PTZ camera control software to configure, monitor, and control all cameras in the system, including the ability to view periodic camera snapshot images.

7.5 System Configuration Parameters

System Administrators have access to various configuration files and properties files to adjust system configuration parameters as necessary.

Also, System Administrators will have access to an Applications tab on the TPLS Administration Website that includes links to the services they will need to manage the system. These will include links to the SNAPS Server, reporting tools, and other important tools. See Section 7.2.6, Access to Support Applications, for additional information.

7.6 Data Archiving and Analysis

The TPLS will store truck parking availability data for historical or archive purposes in a database for later retrieval and analysis. Every 15 minutes, the TPLS will store the following values for a given truck parking lot:

- Total truck parking capacity in parking spaces.
- Adjusted truck parking capacity accounting for spaces taken off-line for maintenance or other operational purposes.
- Average truck parking space availability over the 15-minute period.
- Adjusted average truck parking space availability over the 15-minute period. This adjusted average value will reflect any manual corrections made by an operator to account for equipment problems or anomalies arising in the normal operation of a particular lot.
- Date-and-time stamp of the 15-minute period.

The system will be initially configured to retain historical data for one year, although the data retention period is configurable.

This historical information can be used for TPLS system trouble-shooting purposes, on-going trend analysis, parking lot usage reports, and as input to predictive algorithms to forecast parking usage.

The TPLS software will also include a capability for system administrators to generate a Parking Availability report that shows the average available parking capacity for each instrumented parking facility and time-of-day over different operational periods. As with the IVR telephone system usage reports, the ApexSQL Reports online reporting tool will be used to generate this report. The report results will be available through an HTML preview and can be exported to an Adobe PDF file. Report parameters are as follows:

- Query parameters (user supplied):
  - Date/time range
  - Reporting time frequency (15, 30, or 60 minutes)
  - Lot selection (one or more individual lots, or all lots)

- Sort parameters:
  - Parking lot location (state), lot name, date/time

- Report content (based on 15/30/60-minute intervals):
  - Parking lot location and name
  - Date and time
  - Average parking capacity
  - Adjusted average parking capacity accounting for spaces taken off-line for maintenance or other operational purposes
  - Average parking availability
  - Adjusted average parking space availability. This adjusted average value will reflect any manual corrections made by an operator to account for equipment problems or anomalies arising in the normal operation of a particular lot
  - Totals
    - By lot: Average capacity, average availability
    - All lots: Average capacity, average availability

7.7 System Backup and Restoration

The TPLS will include standard COTS Windows-based, system backup and restore software included in the distribution of Windows Server 2008.

The sections below provide examples of using the included Windows facilities.

7.7.1 Creating a Scheduled Backup

To perform a basic backup with the built-in software, log in to Windows Server 2008 using an account with local administrator privileges:

1. From the command prompt, run ‘servermanagercmd.exe’ -- install Backup-Features.
2. When the backup features have finished installing, open ‘Windows Server Backup’ from ‘Administrative Tools’ on the ‘Start’ menu.
3. In the ‘Actions’ pane on the right, click ‘Backup Schedule’.
4. Click ‘Next’ on the ‘Getting Started’ dialog. Choose ‘Full Server’ on the ‘Select’ backup configuration screen. Click ‘Next’ to continue.
5. On the ‘Specify’ backup time screen, leave the default option of once a day at 21:00 selected and click ‘Next’.
6. On the ‘Select’ destination disk screen, select an external drive (E:\) (see figure below). To select an internal disk, click ‘Show All Available Disks’. Click ‘Next’ to continue.
7. At this point a warning that the destination disk will be dedicated to backup (to facilitate moving the disk offsite) and formatted and hidden from Windows Explorer (to ensure integrity). Click ‘Yes’ to continue.
8. You should note the disk’s label from the ‘Label’ destination disk dialog, and write it on the disk enclosure, if it’s external or removable, so it can be easily identified in the future. Click ‘Next’ and then ‘Finish’ on the confirmation screen. The ‘Backup Schedule’ wizard will then format the disk, and you will be presented with a summary screen, telling you when the first backup is scheduled to run. Click ‘Close’ to continue.
9. The ‘Windows Server Backup’ console under ‘Status (Next Backup)’ and ‘Scheduled Backup’ should now display information about the backup just created. To run the scheduled job ahead of time, click ‘Backup Once’ in the ‘Actions’ pane, in ‘Backup’ options leave the default settings, click ‘Next’ and then ‘Backup’ on the confirmation screen.

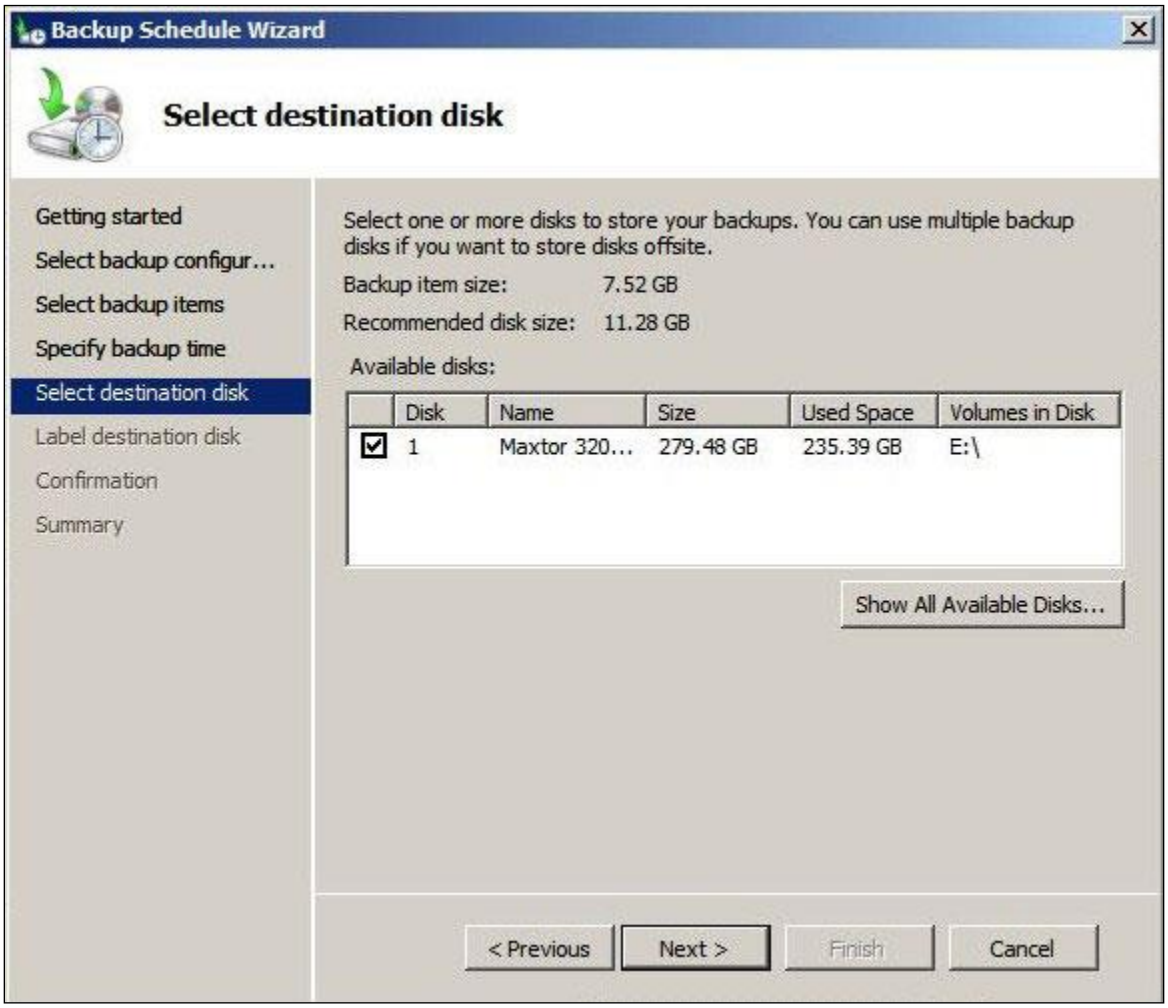


Figure 21. Windows Server 2008 Backup Schedule

7.7.2 Restoring Files

Restoring files can be done from the Windows Server Backup console. To restore a file:

1. Open the 'Windows Server Backup' console from 'Administrative Tools' on the 'Start' menu.
2. Click 'Recover' in the 'Actions' pane on the right.
3. Leave this server selected and click 'Next' on the 'Getting Started' screen.
4. On the 'Select Backup Date' dialog, select the desired date and time of the backup to use as the source of the restore operation and click 'Next' (see figure below).
5. Leave the default option of 'Files and Folders' selected on the 'Select Recovery Type' dialog and click 'Next'.
6. Expand the disk's label under 'Available Items', highlight the desired files for restore in the right pane, and click 'Next' (see figure below).
7. On the 'Select' recover options dialog, leave the default options selected to restore the files to the original location. Click 'Next' to continue.

8. Review the confirmation screen and click Recover. Once the restore is completed, click Close on the Recover progress dialog.

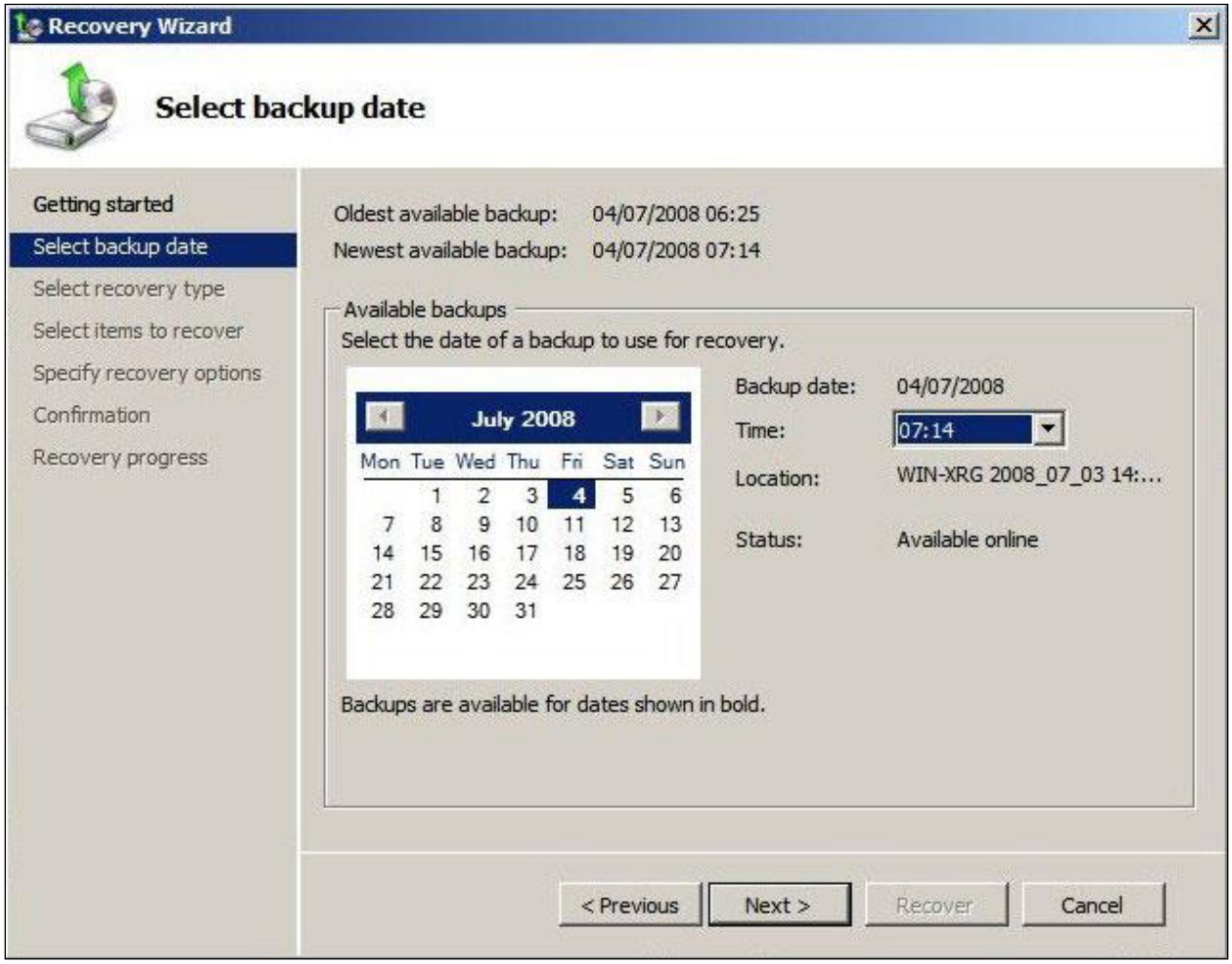


Figure 22. Windows Server 2008 Backup Restore Selection

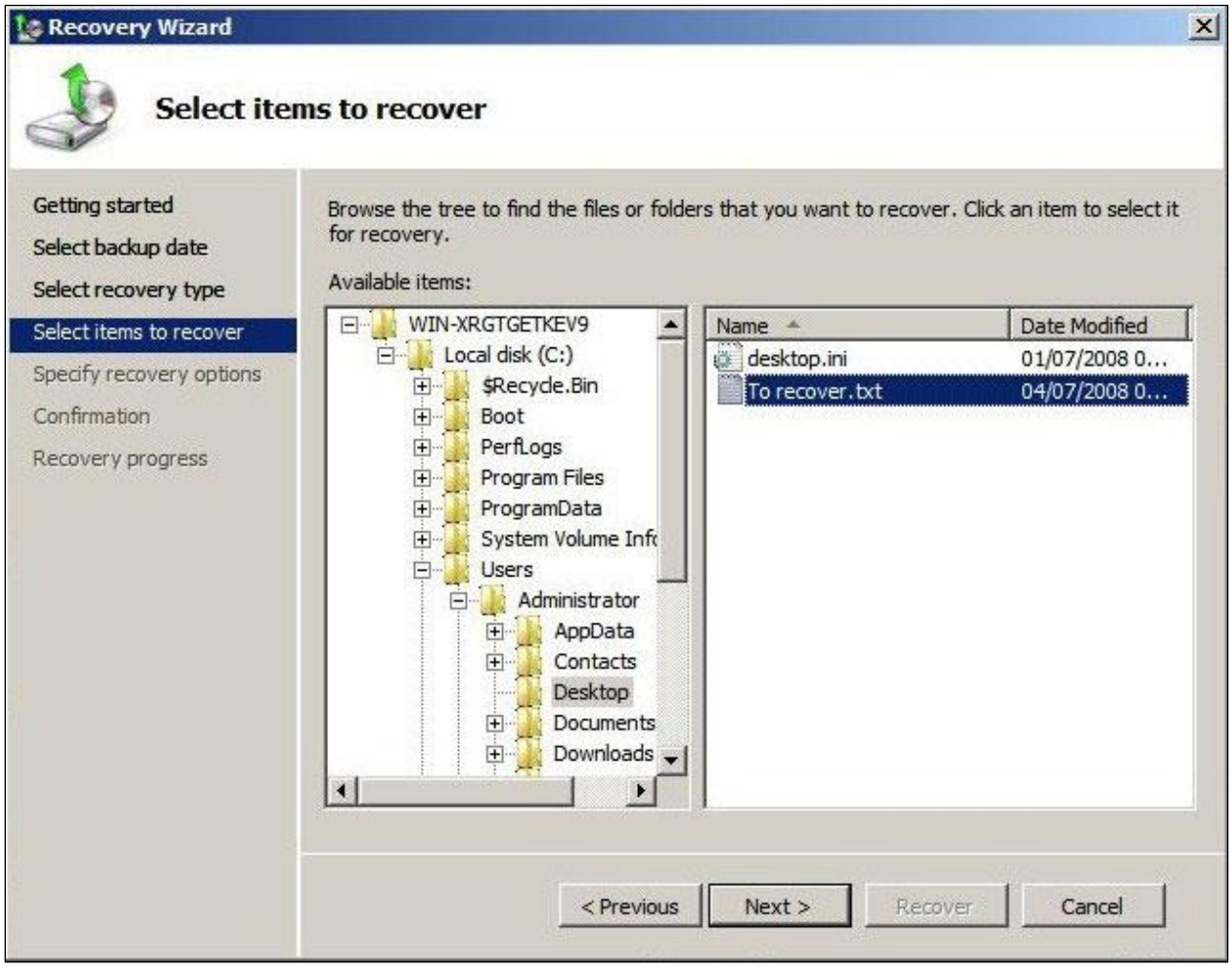


Figure 23. Windows Server 2008 File Restore Selection

7.8 System Startup and Shutdown

This section describes the startup and shutdown dependencies between each of the system components.

Generally, each of the major components operate independently of each other, so no startup or shutdown order needs to be enforced. The exception is the database where all information is persisted. Without the database, none of the components can operate. The following list describes service dependencies between the components.

- Data Collection/Integration – This sub-system consists of polling sensor devices in the parking lots which generally run whenever power is applied. Other than physically powering them off on-site, it can be assumed that this sub-system should always be running.

- Data Dissemination

- IVR Telephone System – The services in the IVR system require a specific order during startup. This order is enforced by the MS Windows Services facility. Some of the services run under the Tomcat container which in turn is started and stopped using the MS Windows Services facility. The startup order is:
    - Database
    - XML Server (within Tomcat)
    - Inbound Process (within Tomcat)
    - Outbound Process (within Tomcat)
    - Call Server
    - Nuance Call Distributor
- Truck Parking Web Service – The website is an outwardly directed service so there are no internal dependencies on it. It depends on the database for its information, so it is only as current as what the other components provide. This service runs under Tomcat which is controlled by the MS Windows Services facility.
- External Data Feed – This feature is implemented by the Data Collection sub-system after each polling cycle. Given that this is an outwardly directed service, there are no internal dependencies on it. Any external service listening to the data feed must recover on their own after a restart of this service.

7.9 Logging and Failure Detection

Each component of the TPLS maintains a logging capability appropriate for the diagnosis of any operational problems that may arise.

In addition, the TPLS will include the What's Up Gold network monitoring software to detect failures and provide associated alerts to Operations and Maintenance staff. The What's Up Gold software will detect failures using the Simple Network Management Protocol (SNMP), which is an industry standard method for reporting system status throughout the network. All computers, routers, and firewalls will support this. The system will be configured to send alerts to specified workstations and e-mail addresses using the What's Up Gold application within one (1) minute of detection of the problem. What's Up Gold will be initially configured to detect general SNMP failures on the main servers, such as available disk space, memory, and communications. Specialized SNMP traps will also be established to detect application-specific errors/failures.

As mentioned previously, SNMP alert traps will also be set when (1) the data collection process encounters a problem in communicating with the parking space management system after a period of time, and (2) the Sensys SNAPS server does not respond to requests for field sensor data. In these situations, the SNMP traps will be sent to the What's Up Gold application, which will notify the O&M operators.

7.10 System Documentation

The Data-Collection module includes an Administrator's Manual documenting the relevant system features and their use in the operation of the Truck Parking Location System. In addition,

system documentation will be provided for the IVR Manager application as well as for administration of the public website. Users of the external data feed will also be provided with documentation on the contents of the data feed and how to access it.

Appendix A. Requirements to Design Elements Traceability

This section describes the traceability between the Truck Parking Location System requirements and the design of the associated functionality. The last column of the table identifies the specific section(s) within this Design document or other related project documents. The ID column contains a unique number identifying the requirement. Each ID uses one of the following prefixes:

- DCI – Data Collection and Integration
- IVR – IVR Telephone System
- WEB – Public Website
- EXT – External Data Feed
- MGT – System Management/Operations

Note that the numbering scheme shown in the requirements table contains some gaps within each prefix. This is due to the removal of potential future requirements and other requirements that no longer apply, so that the document now focuses only on requirements for the initial system release.

Table 7. System Requirements to Design Elements Traceability

ID	Requirement	Comments	System Release	Design Section # or Other Document Reference
DCI 1	The TPLS shall collect parking data using in-ground sensor-based monitoring devices.	In-ground sensor-based monitoring device is to be determined.	Release 1	2.1
DCI 2	The TPLS shall support a REST-based communications protocol to the supported in-ground sensor-based monitoring devices.		Release 1	4.1
DCI 3	The TPLS shall collect data from the supported in-ground sensor-based monitoring devices by parsing its output data stream for status.		Release 1	4.1
DCI 3.1	The TPLS shall parse the in-ground sensor-based monitoring device's output data stream for parking availability data at regular intervals.	Initial interval is one minute.	Release 1	4.2
DCI 4	The TPLS shall support TCP/IP communications to the supported in-ground sensor-based monitoring devices.		Release 1	2.2, 3.2.1, 3.2.3, 3.2.4, 3.2.5, 3.2.6, 3.2.6.1, 3.2.7, 3.2.8, 4.4

ID	Requirement	Comments	System Release	Design Section # or Other Document Reference
DCI 5	The TPLS shall support communications pick-up and drop capability for the supported in-ground sensor-based monitoring devices.		Release 1	4.4
DCI 6	The TPLS shall be capable of collecting data from up to 500 instrumented truck parking areas.		Release 1	4
DCI 7	The TPLS shall be capable of collecting data from up to 500 parking spaces per instrumented truck parking area.		Release 1	4
DCI 8	The TPLS shall collect data from up to two (2) in-ground sensor-based monitoring devices per instrumented truck parking space.		Release 1	2.1, 3.2, 3.2.2, 4.1, 4.2
DCI 9	Each TPLS truck parking space shall be unique and monitored by one or two in-ground sensor-based monitoring devices.		Release 1	2.1, 3.2, 3.2.2, 4.1, 4.2
DCI 10	The TPLS shall determine if an individual parking space is occupied by a vehicle within three (3) minutes upon completion of entering or exiting the parking space.		Release 1	3.2.2
DCI 11	At system startup, the TPLS shall determine if each configured parking space is occupied by a vehicle within five (5) minutes from startup.		Release 1	3.2.2
DCI 12	Individual parking space occupancy reporting shall be 90% reliable or better.		Release 1	Per sensor equipment to be supplied by a third party
DCI 14	The TPLS shall calculate parking availability by parking area.		Release 1	4.2, 6.1.4
DCI 15	The TPLS shall detect changes in parking availability during daytime.		Release 1	3.2.1
DCI 16	The TPLS shall detect changes in parking availability during nighttime.		Release 1	3.2.1
DCI 17	The TPLS shall detect changes in parking availability under clear, cloudy, foggy, rainy, and icy/snowy weather conditions.		Release 1	3.2.1
DCI 18	The TPLS shall detect changes in parking availability under variable lighting conditions.		Release 1	3.2.1

ID	Requirement	Comments	System Release	Design Section # or Other Document Reference
DCI 19	The TPLS shall timestamp and log collected data.		Release 1	4.1, 4.5.3, 4.5.4, 5.1.5, 6.1.4, 7.9, Appendix C
DCI 20	The TPLS shall retain parking availability data in a database for historical purposes for up to one (1) year.		Release 1	2.2, 3.1.1.1, 4.2, 7.6
DCI 21	The TPLS shall be able to designate specific parking spaces as "unavailable" by a trained operator to address parking area construction, maintenance, outdoor storage, snow collection, etc.		Release 1	7.1
DCI 22	The TPLS shall allow manual correction of parking space availability counts by a trained operator.		Release 1	7.1
DCI 23	The TPLS shall capture video snapshots from installed cameras.	For verifying available parking space counts, observing a parking area for damage after a storm, etc.	Release 1	2.1, 3.2, 3.2.5, 7.1, 7.4
DCI 23.1	The TPLS shall capture video snapshots from installed cameras at a configurable interval.	Initial interval will be one frame per minute.	Release 1	3.2.5, 7.4
DCI 23.2	The TPLS shall capture video snapshots from installed cameras at least one (1) frame per minute.		Release 1	3.2.5
DCI 24	The TPLS shall store video snapshots for diagnostic purposes for up to 24 hours.		Release 1	3.2.5
DCI 27	The TPLS shall store the truck parking space capacity for each instrumented parking area.		Release 1	6.1.2, 6.1.5, 7.6, Appendix C
DCI 28	The TPLS shall support Internet Protocol communications to the installed cameras.		Release 1	3.2.5
DCI 31	The TPLS shall designate whether a parking facility is online or offline.		Release 1	5.2.7.2, 6.1.4, 7.2.2, Appendix C

ID	Requirement	Comments	System Release	Design Section # or Other Document Reference
IVR 100	The TPLS shall include an IVR Telephone System.		Release 1	5.1
IVR 101	The TPLS IVR Telephone System shall be able to provide updated parking space availability within 30 seconds from when the TPLS detects a change in availability.		Release 1	5.1.1
IVR 103	The TPLS IVR Telephone System shall sort the list of instrumented parking locations based on the number of available parking spaces in descending order.		Release 1	5.1.1
IVR 104	The TPLS IVR Telephone System shall provide the following information for truck parking locations: a. Parking area name b. Count of available parking spaces with timestamp c. Location parking capacity d. Location information e. Phone number (if available) f. List of basic amenities available (if available)	Location information may include the following: • Roadway • Roadway exit • Roadway mile marker • City/State • Zip code Sample amenities include shower, fuel, restaurant, etc. If only partial information is known on the number of available spaces, the IVR system shall indicate this by use of the phrase “at least”. For example, in response to a request for parking spaces, when 10 spaces are known to be available, and the status of at least one space is unknown, the IVR system shall report ”there are at least 10 spaces available”.	Release 1	5.1.1, 5.1.7, Appendix D
IVR 105	The TPLS IVR Telephone System shall transfer the user to the selected parking location phone number, if available.		Release 1	Appendix D
IVR 107	The TPLS IVR Telephone System shall accept and record user comments for reporting and analysis.		Release 1	Appendix D
IVR 108	The TPLS IVR Telephone System shall process up to 46 concurrent users.		Release 1	3.1.2, 5.1.5
IVR 109	The TPLS IVR Telephone System shall recognize speech-based and touch-tone user responses.		Release 1	3.1.2, 3.1.3, 5.1

ID	Requirement	Comments	System Release	Design Section # or Other Document Reference
IVR 110	The TPLS IVR Telephone System shall automatically call a user's phone back at a single time interval and provide up-to-date parking availability information for the selected location, when requested by the user.	Initial intervals to be determined during design (e.g., 15 minutes, 30 minutes, 60 minutes).	Release 1	5.1.1, 5.1.2, 5.1.5, 5.1.6, Appendix D
IVR 111	The TPLS IVR Telephone System shall call the user back a configurable number of times within a defined time period when a return call is not answered or it cannot be confirmed that the user answered.	Initial number of callbacks to be determined during design. Number of callbacks will be defined as a system-wide parameter, not user-specific.	Release 1	5.1.2, 5.1.6, 5.1.9, Appendix D
IVR 112	The TPLS IVR Telephone System shall allow the user to request a subsequent callback.	Caller will be allowed to change the callback time for the currently selected site(s) (single callback time for all sites) or specify a callback time for a new individual site or all sites within a selected area.	Release 1	5.1.2, 5.1.6, Appendix D
IVR 113	The TPLS IVR Telephone System shall store the user's selected parking request for callback purposes.	Parking request will include allowable callback storage period.	Release 1	5.1.2, 5.1.4, 5.1.6, 5.1.8, 5.2.2, 6.1.8, 6.1.10, Appendix D
IVR 114	The TPLS IVR Telephone System shall capture and store the user's phone number for callback purposes.		Release 1	5.1.4, 5.1.6, 5.1.8, 6.1.8, Appendix D
IVR 116	The TPLS IVR Telephone System shall provide context-sensitive help information corresponding to the caller's location in the system.		Release 1	Appendix D
IVR 117	The TPLS IVR Telephone System shall be accessible through a toll-free telephone number.		Release 1	5.1
IVR 118	The TPLS IVR Telephone System shall utilize live speech, concatenated speech, and text-to-speech, as appropriate, for prompts and responses.		Release 1	5.1

ID	Requirement	Comments	System Release	Design Section # or Other Document Reference
IVR 119	The TPLS IVR Telephone System shall support "barge-in," which allows the caller to interrupt messages to select the desired option.		Release 1	5.1
IVR 120	The TPLS IVR Telephone System shall accept call transfers from 511 systems.		Release 1	5.1
IVR 121	The TPLS IVR Telephone System shall allow the user to search by area or truck stop/rest area name to determine the desired parking location.	Preliminary areas for Tier I are: • Delaware • Maryland • Virginia	Release 1	5.1.1, Appendix D
IVR 123	The TPLS IVR Telephone System shall provide English prompts and responses.		Release 1	5.1
IVR 126	The TPLS IVR Telephone System shall indicate if an instrumented parking facility is offline (i.e., not operational).		Release 1	5.1.8, 6.1.4, Appendix D (Play Parking Information Call Flow diagram)
WEB 200	The TPLS shall include a Public Website.		Release 1	5.2, 5.2.3
WEB 201	The TPLS Public Website shall be able to provide updated parking space availability within 30 seconds from when the TPLS detects a change in availability.		Release 1	5.2.1
WEB 203	The TPLS Public Website shall provide an interactive map identifying instrumented parking locations.		Release 1	5.2.7.2
WEB 203.1	The TPLS Public Website map shall provide pan-and-zoom capabilities.		Release 1	5.2.7.2
WEB 203.2	The TPLS Public Website map shall allow the user to select from pre-defined map views.		Release 1	5.2.7.2
WEB 204	The TPLS Public Website shall list instrumented parking locations in a tabular format.		Release 1	5.2.7.3

ID	Requirement	Comments	System Release	Design Section # or Other Document Reference
WEB 205	The TPLS Public Website shall provide the following information for truck parking locations: a. Parking area name b. Count of available parking spaces c. Last update date and time d. Total parking location capacity e. Location address f. Contact information (e.g., website, phone number), if available g. List of available parking amenities (if available)	Location information may include the following: • Roadway • Roadway exit • Roadway mile marker • City/State • Zip code Sample amenities include shower, fuel, restaurant, etc. If only partial information is known on the number of available spaces, the Public Website shall indicate this by use of the phrase "at least". For example, when 10 spaces are known to be available, and the status of at least one space is unknown, when displaying the number of parking spaces, the Public Website will show "at least 10".	Release 1	5.2.7.2, 5.2.7.3
WEB 206	The TPLS Public Website shall provide directions to a selected parking location using Google Maps.		Release 1	5.2.7.2
WEB 207	The TPLS Public Website shall provide useful links to related external websites.	Examples include transportation agencies, weather, 511 systems, http://www.i95exitguide.com/restareas)	Release 1	5.2.7.5
WEB 208	The TPLS Public Website shall provide an "alert" capability to display critical information (e.g., specific parking area disruption) on the website home page.		Release 1	5.2.7.1
WEB 209	The TPLS Public Website shall provide user help containing a list of frequently asked questions (FAQ's).		Release 1	5.2.7.7
WEB 209.1	The TPLS Public Website shall support inclusion of updated FAQ's.		Release 1	5.2.7.8
WEB 210	The TPLS Public Website shall provide contact information (i.e., e-mail address) for users to ask TPLS-related questions.		Release 1	5.2.7.7
WEB 211	The TPLS Public Website shall accept and store user comments for reporting and analysis.		Release 1	5.2.7.6

ID	Requirement	Comments	System Release	Design Section # or Other Document Reference
WEB 212	The TPLS Public Website shall provide an optional user account function.	Only needed for callback purposes.	Release 1	5.2.6
WEB 212.1	The TPLS Public Website optional user account function shall maintain the following information provided by the user: a. Mobile phone number b. Username c. Password d. E-mail address e. Parking area(s) of interest f. Date and time to automatically call user with truck parking availability information for specific parking area(s) g. Security question and response (in case user forgets password) h. Activation/deactivation of callback function		Release 1	5.2.6, 5.2.7.4
WEB 212.2	The TPLS Public Website user shall allow a user to add, edit, or delete his/her user account info.		Release 1	5.2.6
WEB 212.3	The TPLS Public Website shall require the user to login with a valid username and password in order to manage his/her user account information.		Release 1	5.2.6, 5.2.7.4
WEB 213	The TPLS Public Website shall process up to 100 concurrent users.		Release 1	5.2
WEB 214	The TPLS Public Website shall be viewable through the following browsers: a. Microsoft Internet Explorer Versions 6, 7, 8, and 9 b. Mozilla Firefox Version 21	Due to multiple short-term releases, Firefox versions other than 21 will be supported on a case-by-case basis: Version Initial Release End of Life 17 11/20/12 12/3/13 18 1/8/13 2/19/13 19 2/19/13 4/2/13 20 4/2/13 5/14/13 21 5/14/13 6/25/13 22 6/25/13 8/6/13 23 8/6/13 9/17/13 24 9/17/13 10/29/13 25 10/29/13 12/10/13 26 12/10/13 TBD 27-29 TBD	Release 1	5.2.4

ID	Requirement	Comments	System Release	Design Section # or Other Document Reference
WEB 215	The TPLS Public Website shall automatically refresh at a configurable interval.	Initial interval is five minutes.	Release 1	5.2.7.2
WEB 216	The TPLS Public Website shall meet the accessibility standards set forth in Section 508 of the U.S. Rehabilitation Act.		Release 1	5.2.7.10
WEB 217	The TPLS Public Website shall display a "Privacy Statement" covering the usage of information collected by this website.		Release 1	5.2.7.9
WEB 218	The TPLS Public Website shall display a "Terms of Use Statement" disclosing how information gathered at this website may be used.		Release 1	5.2.7.9
WEB 219	The TPLS Public Website shall allow the user to search by area and amenity (e.g., electrification, showers) to determine the desired parking location.	Preliminary areas for Tier I are: • Delaware • Maryland • Virginia	Release 1	5.2.7.3
WEB 220	The TPLS Public Website shall provide English language content.		Release 1	5.2.7.1
WEB 224	The TPLS Public Website shall indicate if an instrumented parking facility is offline (i.e., not operational).		Release 1	5.2.7.2
EXT 300	The TPLS shall include an external data export facility.	Can be used to support interfaces with navigation systems, carrier dispatch systems (e.g., Qualcomm), TMC systems, etc.	Release 1	5.3
EXT 301	The TPLS external data export facility shall publish external data files containing truck parking availability data for each monitored location.		Release 1	5.3, 5.3.2
EXT 301.1	The TPLS external data export files shall be written and maintained in a published XML format.		Release 1	5.3.1, 5.3.4, Appendix E
EXT 301.2	The TPLS external data export shall update the external data files at a configurable interval.	Initial interval is five minutes.	Release 1	5.3, 5.3.1, 5.3.4
EXT 302	The TPLS external data export files shall be accessible to external systems.	This will not be subscription-based. External systems will access the export files using FTP or similar file accessing method.	Release 1	5.3, 5.3.1

ID	Requirement	Comments	System Release	Design Section # or Other Document Reference
EXT 303	The TPLS external data files shall include the following information for each monitored parking location: a. Parking area ID b. Parking area name c. Last update date and time d. Parking area status (online/offline) e. Count of available parking spaces f. Total parking location capacity g. Count of offline spaces h. Error code(s), if applicable		Release 1	5.3.4, Appendix E
EXT 304	The TPLS shall include documentation on accessing and using the data contained in the external data export files.	For use by agencies interested in accessing the data feed.	Release 1	7.10, Appendix E
MGT 400	The TPLS shall include a secure System Administration user interface ("TPLS Administration Website") available only to TPLS System Administration staff.		Release 1	7 and sub-sections
MGT 401	The TPLS shall protect against unauthorized access to the TPLS Administration Website through the use of User ID and Password prompts for authenticating user access.		Release 1	7.2, 7.3 7.4
MGT 402	The TPLS Administration Website shall display system performance information for System Administration staff to monitor the health of the system.		Release 1	7.1, 7.2.2, 7.2.6
MGT 403	The central TPLS shall simultaneously display video snapshots from multiple installed cameras at instrumented parking lots to System Administration staff only.		Release 1	7.4
MGT 404	The TPLS Administration Website shall allow System Administration staff to modify system configuration parameters.		Release 1	2.2, 7.2.6, 7.5, 7.8
MGT 406	The TPLS Administration Website shall allow System Administration staff to play, delete, and download user feedback captured from the TPLS IVR Telephone System.		Release 1	7.3

ID	Requirement	Comments	System Release	Design Section # or Other Document Reference
MGT 407	The TPLS Administration Website shall allow System Administration staff to upload, download, play, delete, search, and organize system recordings for the TPLS IVR Telephone System.		Release 1	7.2.6, 7.3
MGT 408	The TPLS Administration Website shall allow System Administration staff to add, edit, and delete user accounts for users on the TPLS Public Website.		Release 1	7.2.3
MGT 409	The TPLS Administration Website shall allow System Administration staff to add, edit, and delete TPLS Public Website alerts.		Release 1	7.2.1
MGT 410	The TPLS Administration Website shall allow System Administration staff to view, delete, and print user feedback information captured from the TPLS Public Website.		Release 1	7.2.4
MGT 411	The TPLS shall include documentation on administration of the TPLS.		Release 1	7.3, 7.10
MGT 412	The TPLS shall archive truck parking data for performance measurements and analyses purposes.		Release 1	2.2, 4.2, 7.6
MGT 412.1	The TPLS shall archive truck parking data for a configurable period of time.	Initial time period is one year.	Release 1	2.2, 4.2, 7.6
MGT 413	The TPLS shall generate reports from stored data in the system database.		Release 1	7.2.5, 7.3, 7.6
MGT 413.1	The TPLS shall generate reports on average parking capacity and availability, by facility and time-of-day, over a specified period of time.		Release 1	7.6
MGT 413.2	The TPLS shall generate usage reports over a specified period of time for the TPLS Public Website. These reports shall include: a. Total visits b. Total unique visitors c. Average length of visit d. Highest volume time of day e. Number of user accounts		Release 1	7.2.3, 7.2.5

ID	Requirement	Comments	System Release	Design Section # or Other Document Reference
MGT 413.3	The TPLS shall generate usage reports over a specified period of time for the TPLS IVR Telephone System. These reports shall include: a. Total calls b. Average call duration c. Total unique callers d. Peak calling period e. Frequently requested parking locations		Release 1	7.3
MGT 414	The TPLS shall generate system administration reports to monitor the status and health of the TPLS.	See various sub-sections within Section 7, System Management and Operations, for specific reports.	Release 1	2.2, 3.1, 4, 7.1, 7.2.2, 7.9
MGT 415	The TPLS shall log system activities for auditing and troubleshooting.	See Section 7.9, Logging and Failure Detection, for types of logging activities..	Release 1	5.3.3, 7.9
MGT 416	The TPLS shall detect and log system failures.		Release 1	7.9
MGT 417	The TPLS shall send an alert to System Administration staff when a system failure occurs.		Release 1	4.3, 7.9
MGT 417.1	The TPLS shall send an alert to System Administration staff within one minute of detecting a system failure.		Release 1	7.9
MGT 418	The TPLS shall backup and restore system data.		Release 1	7.7
MGT 419	The TPLS shall function with 24x7 reliability with a minimum availability of 99%, excluding scheduled maintenance.	The amount of time for scheduled maintenance is TBD.	Release 1	3.1.1
MGT 420	The TPLS shall include redundant application and database servers to ensure maximum system availability.		Release 1	3.1, 3.1.1, 3.1.1.1, 3.1.3, 3.3
MGT 423	The TPS Administration Website shall allow System Administration staff to edit amenity information for each parking area.		Release 1	7.2.2
MGT 424	The TPLS Administrative Website shall allow System Administration staff to monitor and configure system devices.	Example devices: In-ground sensors, cameras.	Release 1	7.1.1, 7.2.6, 7.4

ID	Requirement	Comments	System Release	Design Section # or Other Document Reference
MGT 425	The TPLS Administrative Website shall display whether a parking space is online or offline.		Release 1	7.2.2

Appendix B. Design Elements to Requirements Traceability

This section demonstrates the traceability from the Truck Parking Location System design to the requirements. The Design Element column in the table, below, refers to the numbered section within this document, and the Requirement ID column represents the specific requirement as shown in Appendix A.

Note that there are a small number of design elements that do not trace directly to a system requirement; these design elements are indicated with "N/A" in the table below. In these instances, the design element is included for the purpose of establishing context and furnishing background information, even though it does not trace directly to a requirement.

Table 8. Design Elements to System Requirements Traceability

Chapter	Design Element	Requirement ID
2	2.1	DCI 1, 8, 9, 23
	2.2	DCI 4, 20, MGT 404, 412, 412.1, 414
	2.3	Throughout
3	3.1	MGT 414, 420
	3.1.1	MGT 419, 420
	3.1.1.1	DCI 20, MGT 420
	3.1.2	IVR 108, 109
	3.1.3	IVR 109, MGT 420
	3.2	DCI 8, 9, 23
	3.2.1	DCI 4, 15, 16, 17, 18
	3.2.2	DCI 8, 9, 10, 11
	3.2.3	DCI 4
	3.2.4	DCI 4
	3.2.5	DCI 4, 23, 23.1, 23.2, 24, 28
	3.2.6	DCI 4
	3.2.6.1	DCI 4
	3.2.7	DCI 4
	3.2.8	DCI 4
	3.3	MGT 420
4	4	DCI 6, 7, MGT 414
	4.1	DCI 2, 3, 8, 9, 19
	4.2	DCI 3.1, 8, 9, 14, 20, MGT 412, 412.1
	4.3	MGT 417
	4.4	DCI 4, 5
	4.5	DCI 19
5	5.1	IVR 100, 101, 109, 117, 118, 119, 120, 123
	5.1.1	IVR 103, 104, 110, 121
	5.1.2	IVR 110, 111, 112, 113
	5.1.3	IVR 104
	5.1.4	IVR 113, 114
	5.1.5	DCI 19, IVR 108, 110
	5.1.6	IVR 110, 111, 112

Chapter	Design Element	Requirement ID
	5.1.7	IVR 104
	5.1.8	IVR 113, 114, 126
	5.1.9	IVR 111
	5.2	WEB 200, WEB 213
	5.2.1	WEB 201
	5.2.2	IVR 113
	5.2.3	WEB 200
	5.2.4	WEB 214
	5.2.5	N/A
	5.2.6	WEB 212, 212.1, 212.2, 212.3
	5.2.7.1	WEB 208, 220
	5.2.7.2	DCI 31, WEB 203, 203.1, 203.2, 204, 205, 206, 215, 224
	5.2.7.3	WEB 205, 219
	5.2.7.4	WEB 212.1, 212.3
	5.2.7.5	WEB 207
	5.2.7.6	WEB 211
	5.2.7.7	WEB 209, 210
	5.2.7.8	WEB 209.1
	5.2.7.9	WEB 217, 218
	5.2.7.10	WEB 216
	5.3	EXT 300, 301, 301.2, 302
	5.3.1	EXT 301.1, 301.2, 302
	5.3.2	EXT 301
	5.3.3	MGT 415
	5.3.4	EXT 301.1, 301.2, 303
6	6.1 (and sub-sections)	DCI 14, 19, 27, 31, IVR 113, 114, 126
7	7	MGT 400
	7.1	DCI 21, 22, 23, MGT 402, 414
	7.1.1	MGT 424
	7.2	MGT 401
	7.2.1	MGT 409
	7.2.2	DCI 311, MGT 402, 414, 423, 425
	7.2.3	MGT 408, 413.2
	7.2.4	MGT 410
	7.2.5	MGT 413, 413.2
	7.2.6	MGT 402, 404, 407, 424
	7.3	MGT 401, 406, 407, 411, 413, 413.3
	7.4	DCI 23, 23.1, MGT 401, 403, 424
	7.5	MGT 404
	7.6	DCI 20, 27, MGT 413
	7.7	MGT 412, 412.1, 413.1, 418
	7.8	MGT 404
	7.9	DCI 19, MGT 414, 415, 416, 417, 417.1
	7.10	EXT 304, MGT 411

Appendix C. Database Entity Relationship Diagrams

The following three figures are entity relationship diagrams (ERD) for the Truck Parking Location System that defines the relationships between the various database tables comprising the system. The first diagram represents the tables shared between multiple system modules. The second diagram shows the tables specific to the Data Collection Subsystem. The final diagram shows the tables specific to the public website. Detailed schema definitions are provided in the following sections in this document:

- Section 4.5 – Common System Tables
- Section 6.1 – IVR Telephone System and Public Website

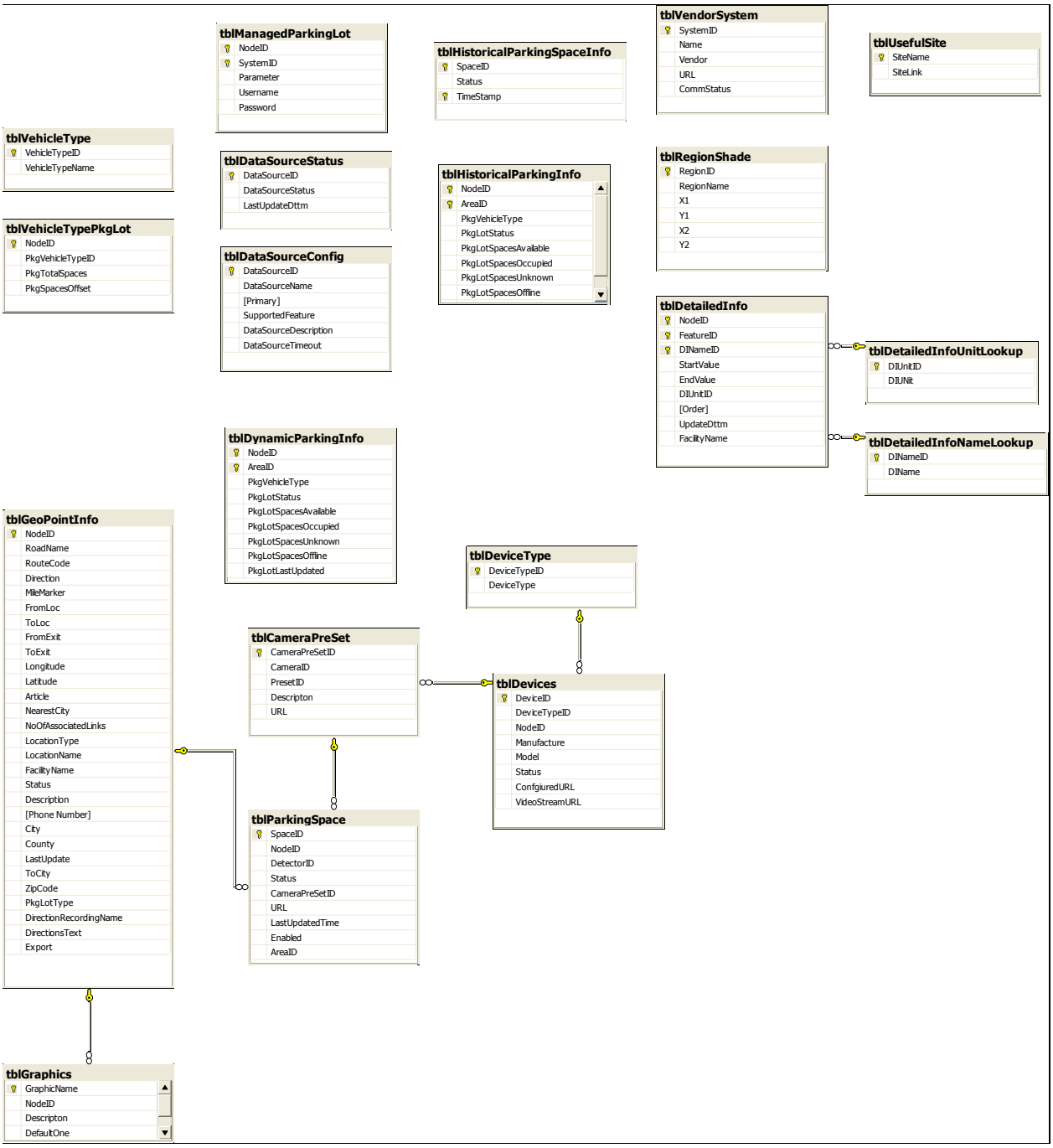


Figure 24. Entity Relationship Diagram for Common Database Tables (Shared Tables between Data Collection, IVR and Public Website)

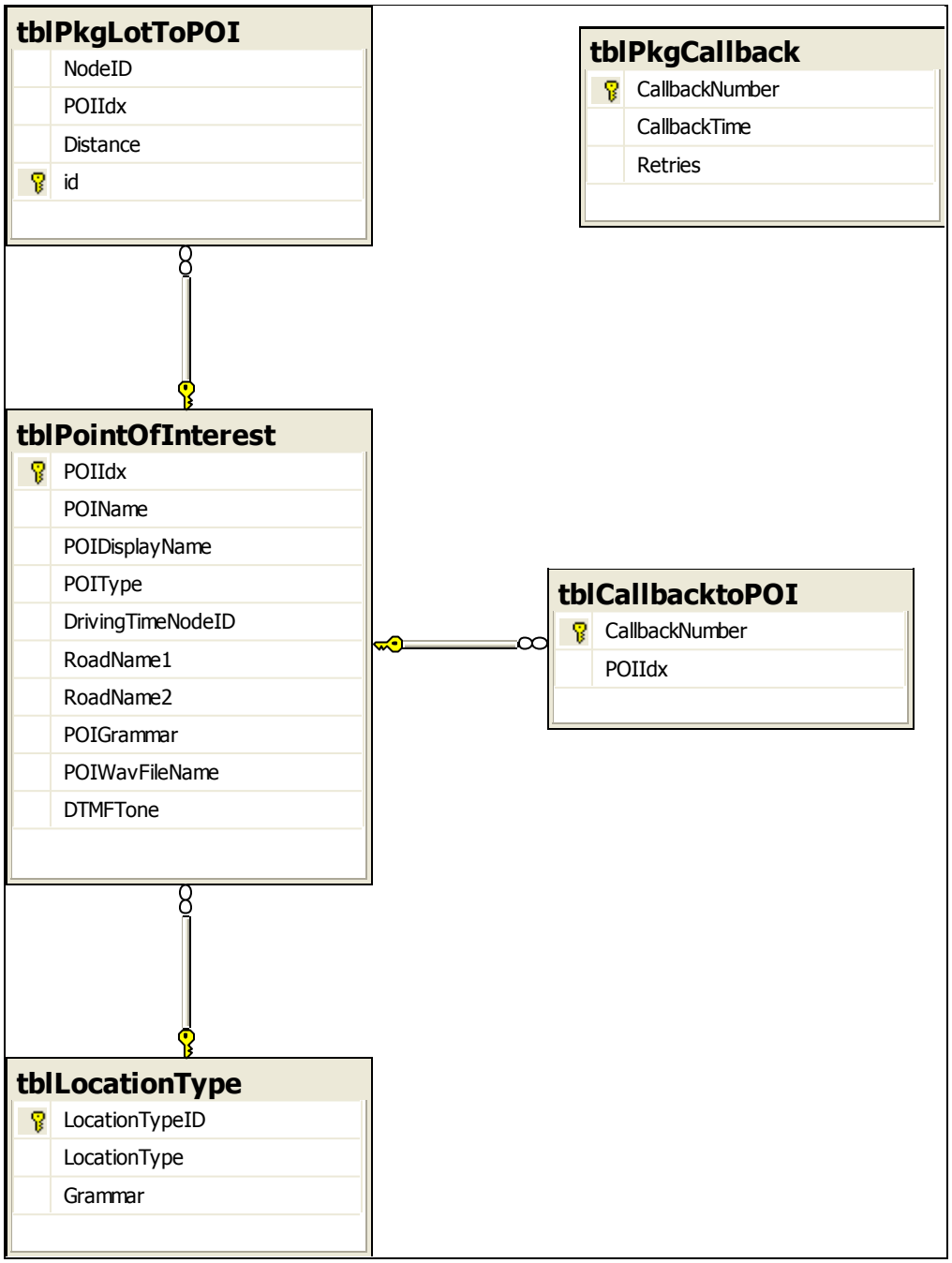


Figure 25. Entity Relationship Diagram for Truck Parking IVR Telephone System Database Tables

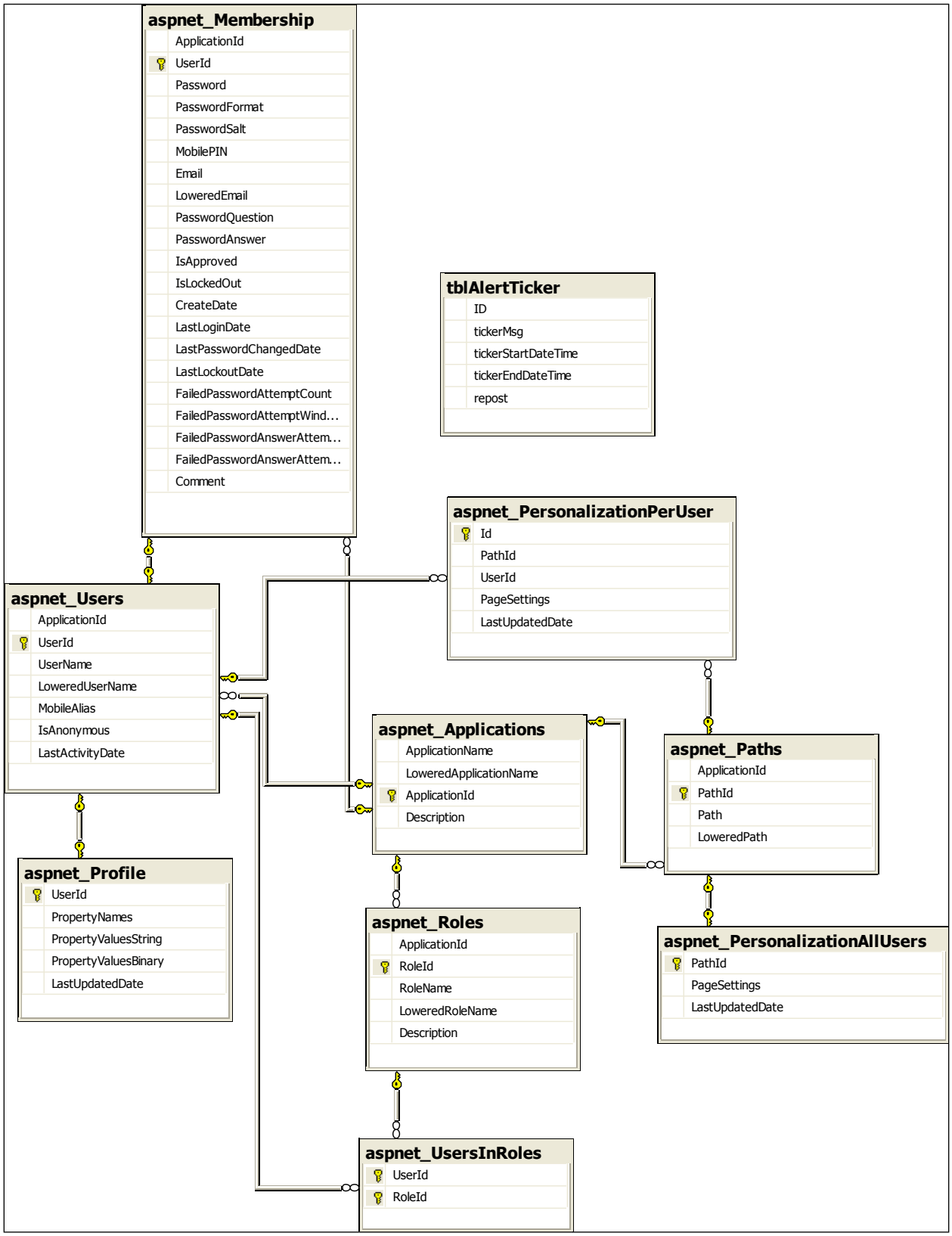


Figure 26. Entity Relationship Diagram for Public Website Database Tables

Appendix D. IVR Call-Flow Diagrams

This section provides the IVR call flow diagrams that depict how the caller interacts with the IVR telephone system, and the system logic used in providing the necessary information to the caller.

Notes:

1) NSP stands for "No Speech Timeout", and refers to a caller staying silent [does not include touchtones].

2) The general error strategy is that after 3 or 4 misrecognitions or NSPs, the caller will be taken to the previous state of the application. Exceptions are noted. After either type of error, an appropriate error message is always played such as, "I'm sorry, I didn't understand," or "I'm sorry, I didn't hear anything."

3) The prompts used in these callflows are "functional": that is, they represent the behavior of the final application, but are by no means the final prompt wordings.

4) Help prompts and error prompts are not shown in the callflows. Every state is assumed to have a Help prompt and appropriate Error prompts.

5) System prompts (prompts the caller hears) and possible caller utterances (things the caller says) are indicated in the callflow with quotation marks ("").

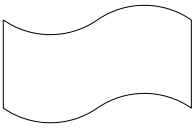
6) Terms used in the callflows do not necessarily reflect the wording callers will hear in the system prompts.

7) All prompt files can be “barged in” on/interrupted.

Key

Recognition State

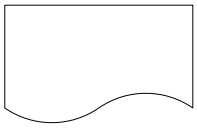
Recognition State using Hotword (only utterances that are in the grammar will barge-in)



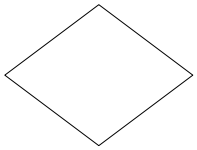
Non-Recognition State - a prompt is played, but no recognition takes place

Back-end process - no recognition occurs, and no prompts are played

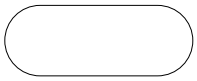
Sample XML API request to the Back-end



Prompt - This prompt is part of the previous recognition state



Decision point (made by the application)



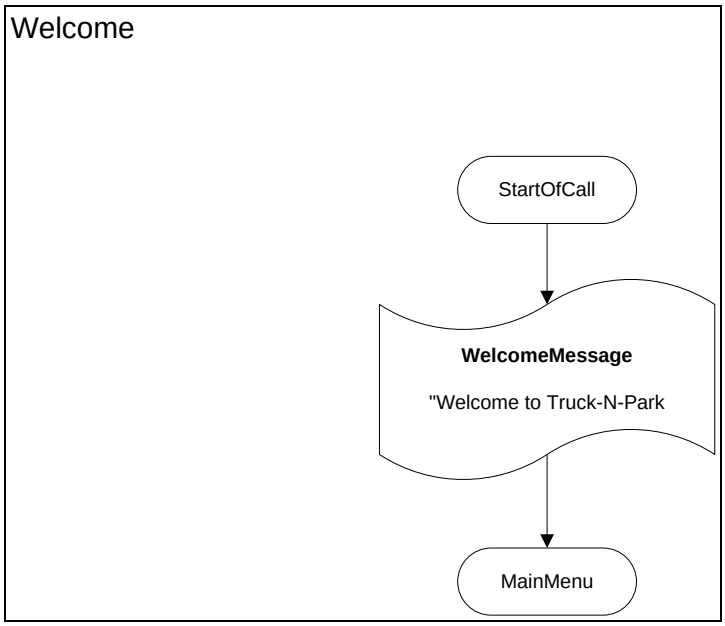
Entry or Exit

Points to a dialog on another page

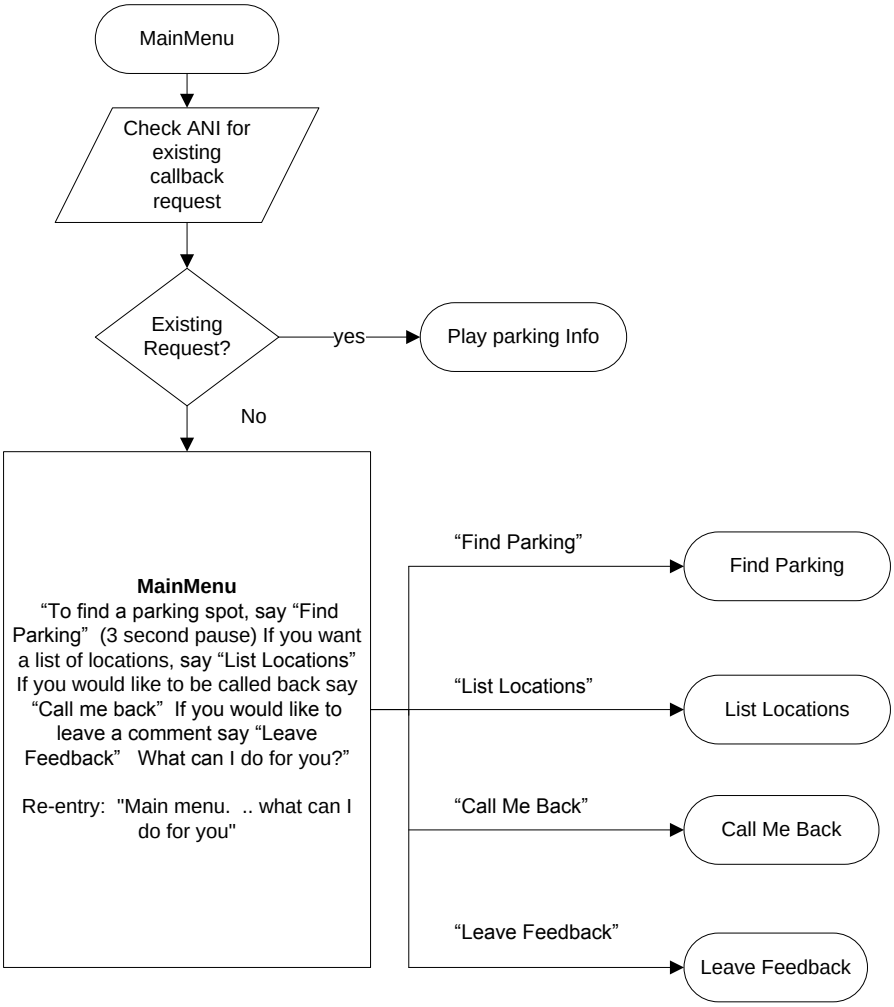
Transfer outside of application

\#

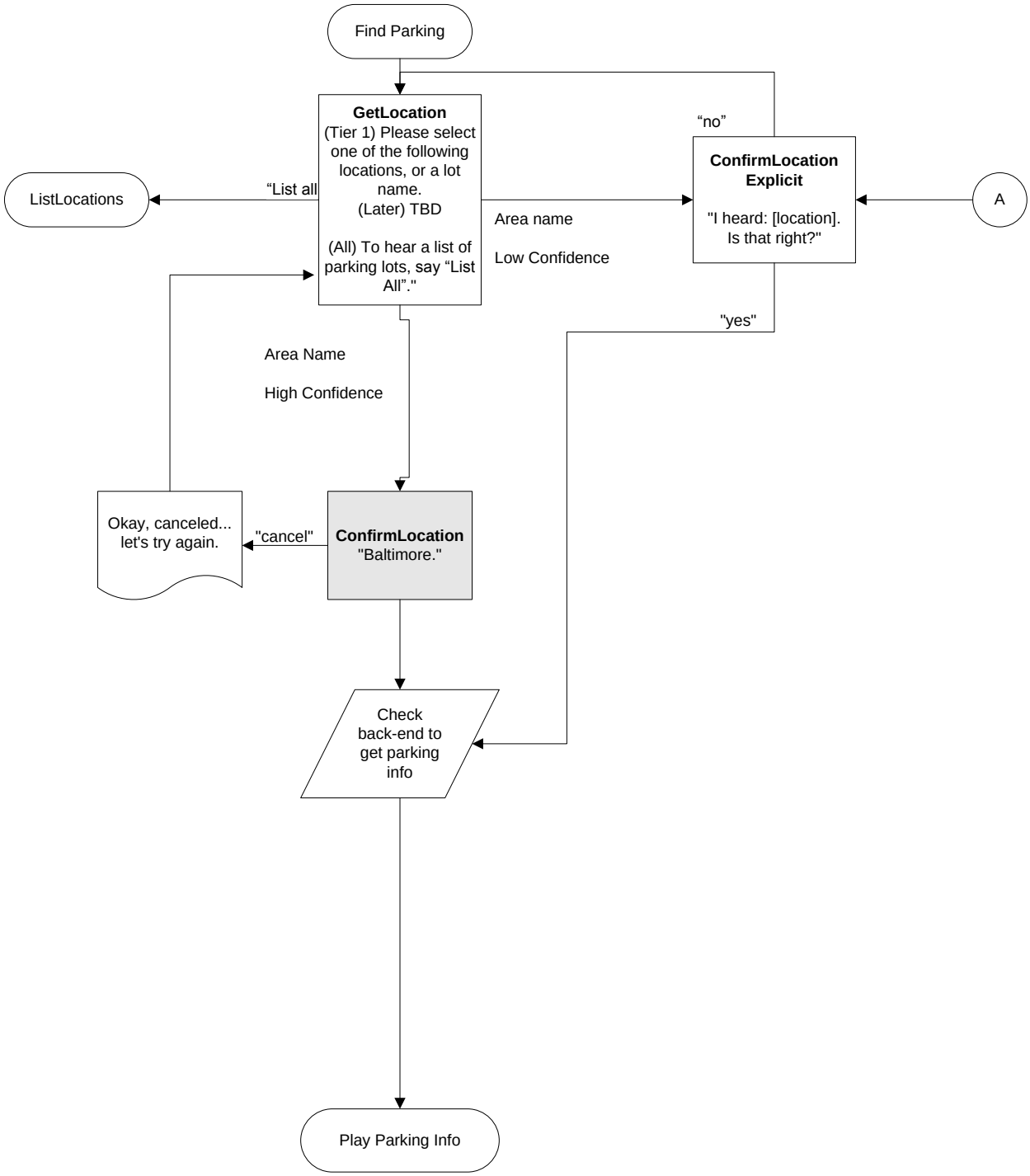
Indicates DTMF (touch-tone) dialog flow will differ from speech dialog flow, and the behavior is shown in the DTMF callflows


Welcome
StartOfCall
WelcomeMessage
"Welcome to Truck-N-Park
MainMenu

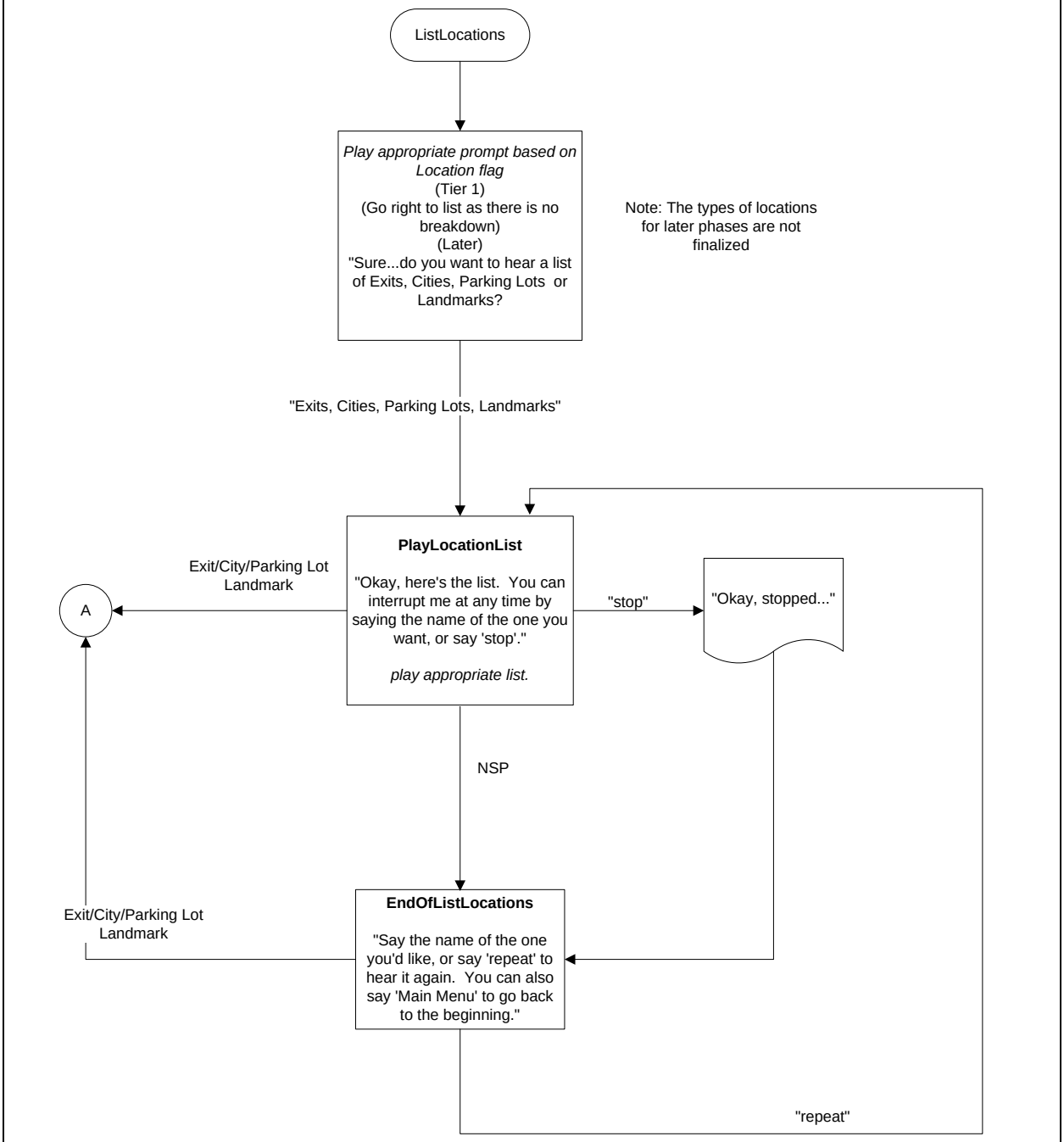
Main Menu


MainMenu
Check ANI for existing callback request
Existing Request?
yes
Play parking Info
No
MainMenu
"To find a parking spot, say "Find Parking" (3 second pause) If you want a list of locations, say "List Locations" If you would like to be called back say "Call me back" If you would like to leave a comment say "Leave Feedback" What can I do for you?"
Re-entry: "Main menu. .. what can I do for you"
"Find Parking"
Find Parking
"List Locations"
List Locations
"Call Me Back"
Call Me Back
"Leave Feedback"
Leave Feedback

Find Parking

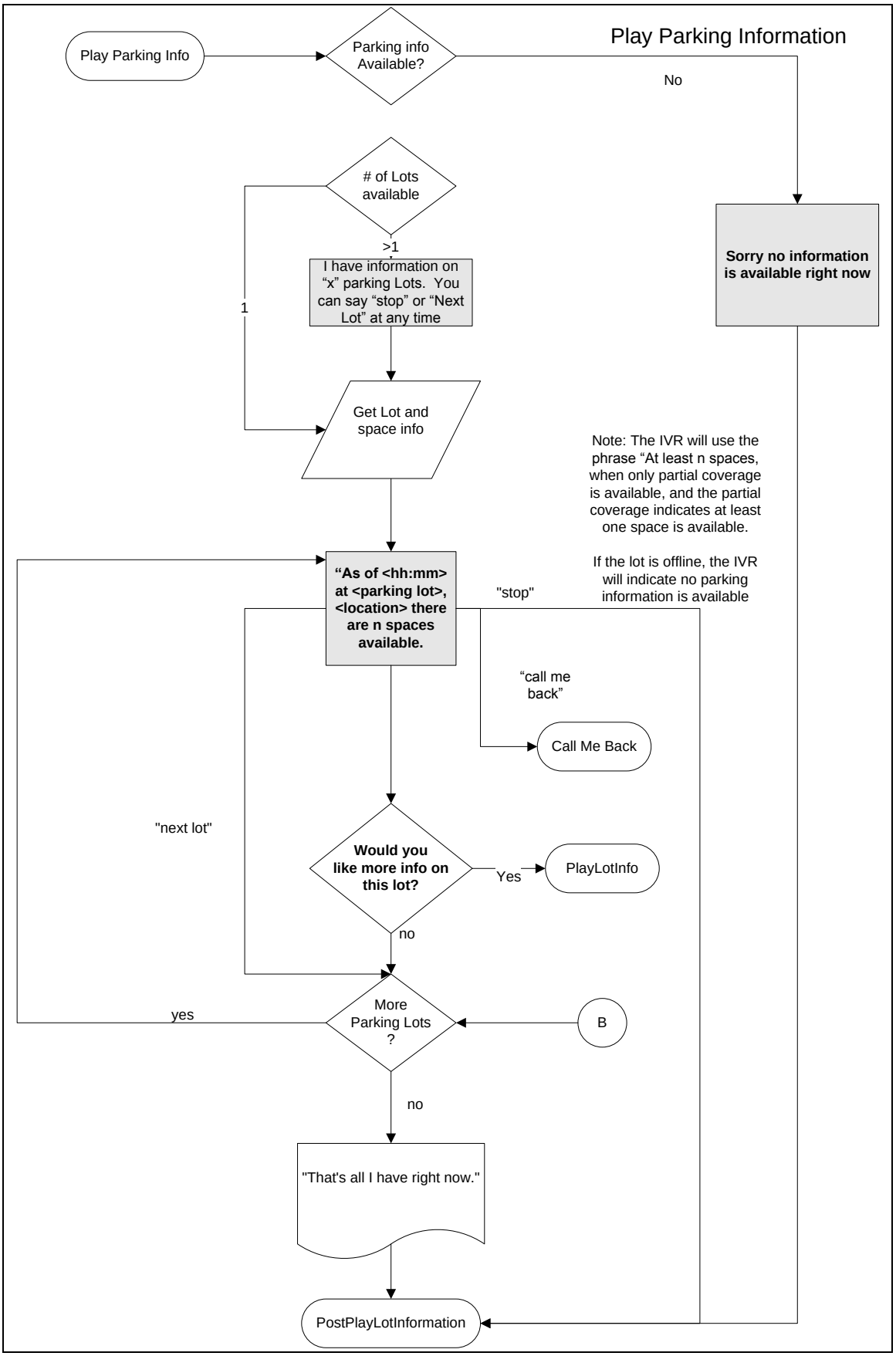


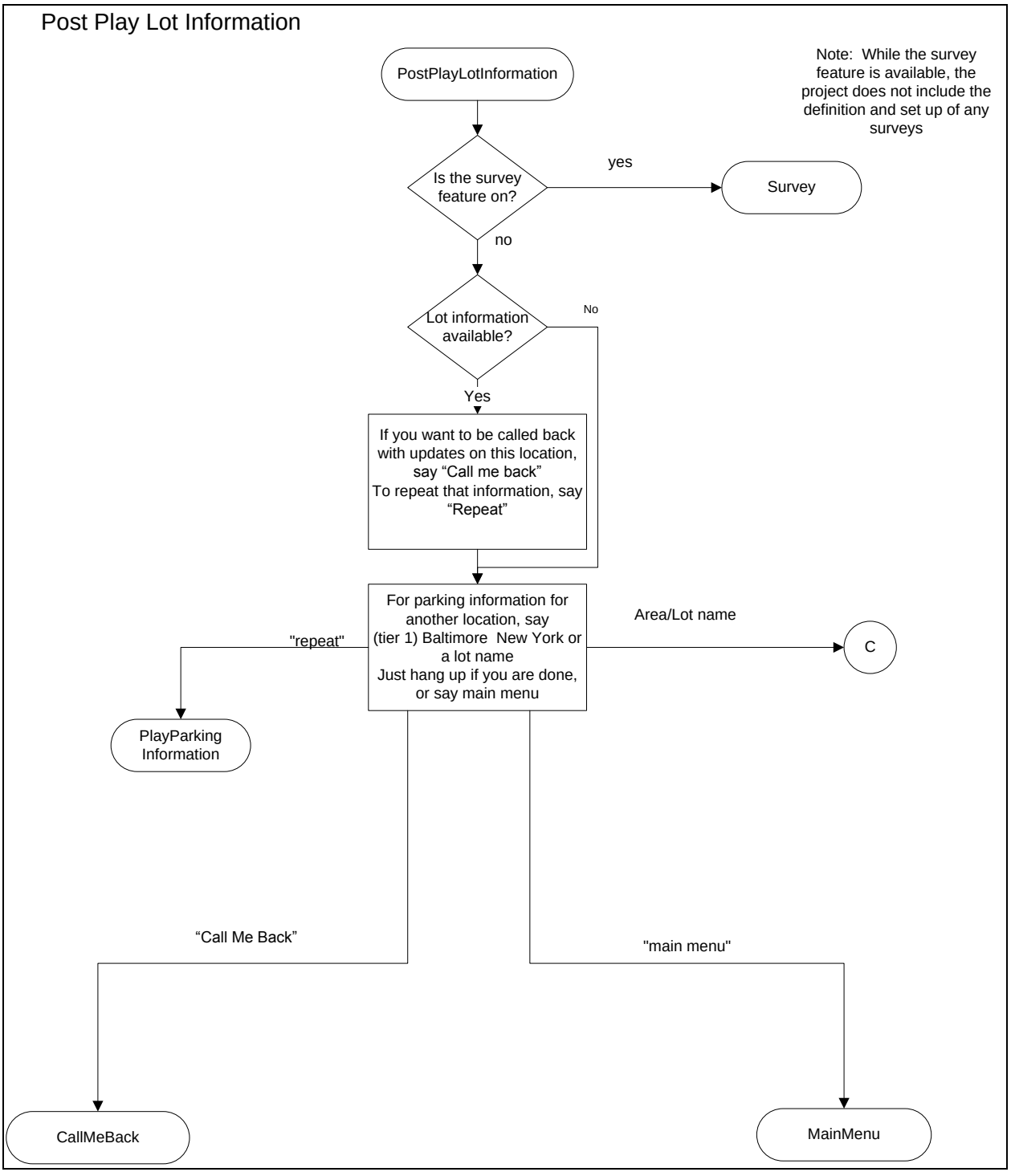
List Locations

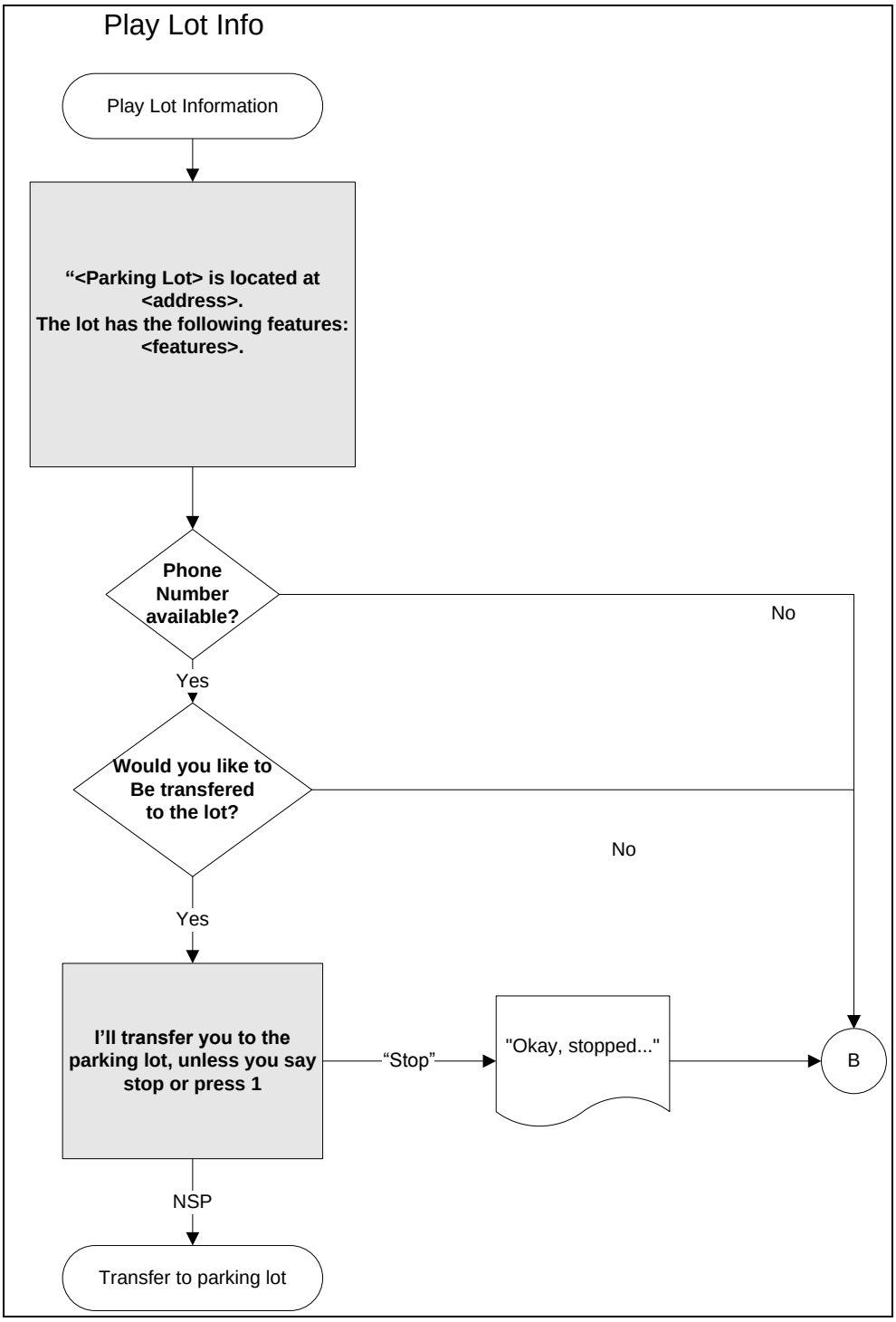


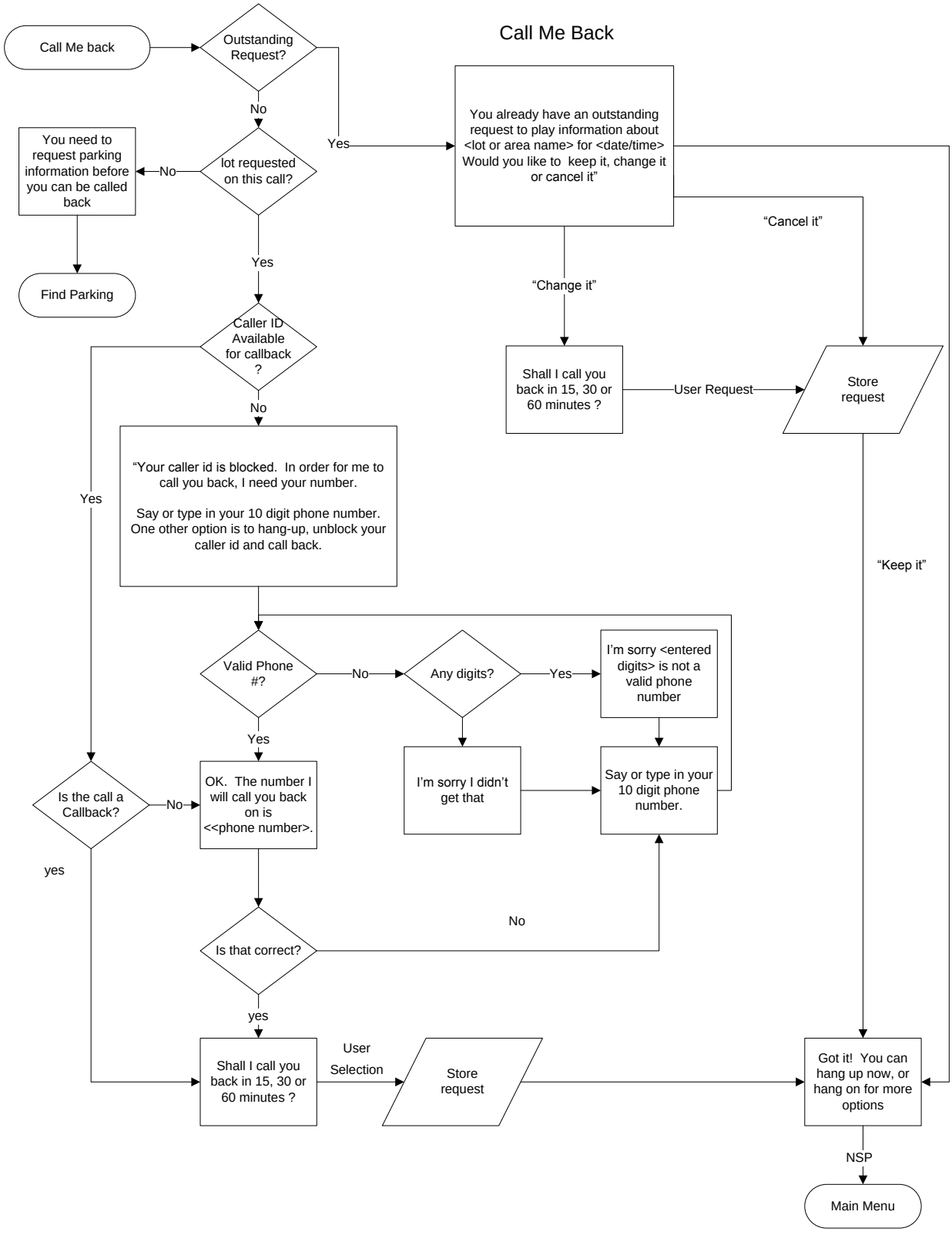
Notes about PlayLocationList

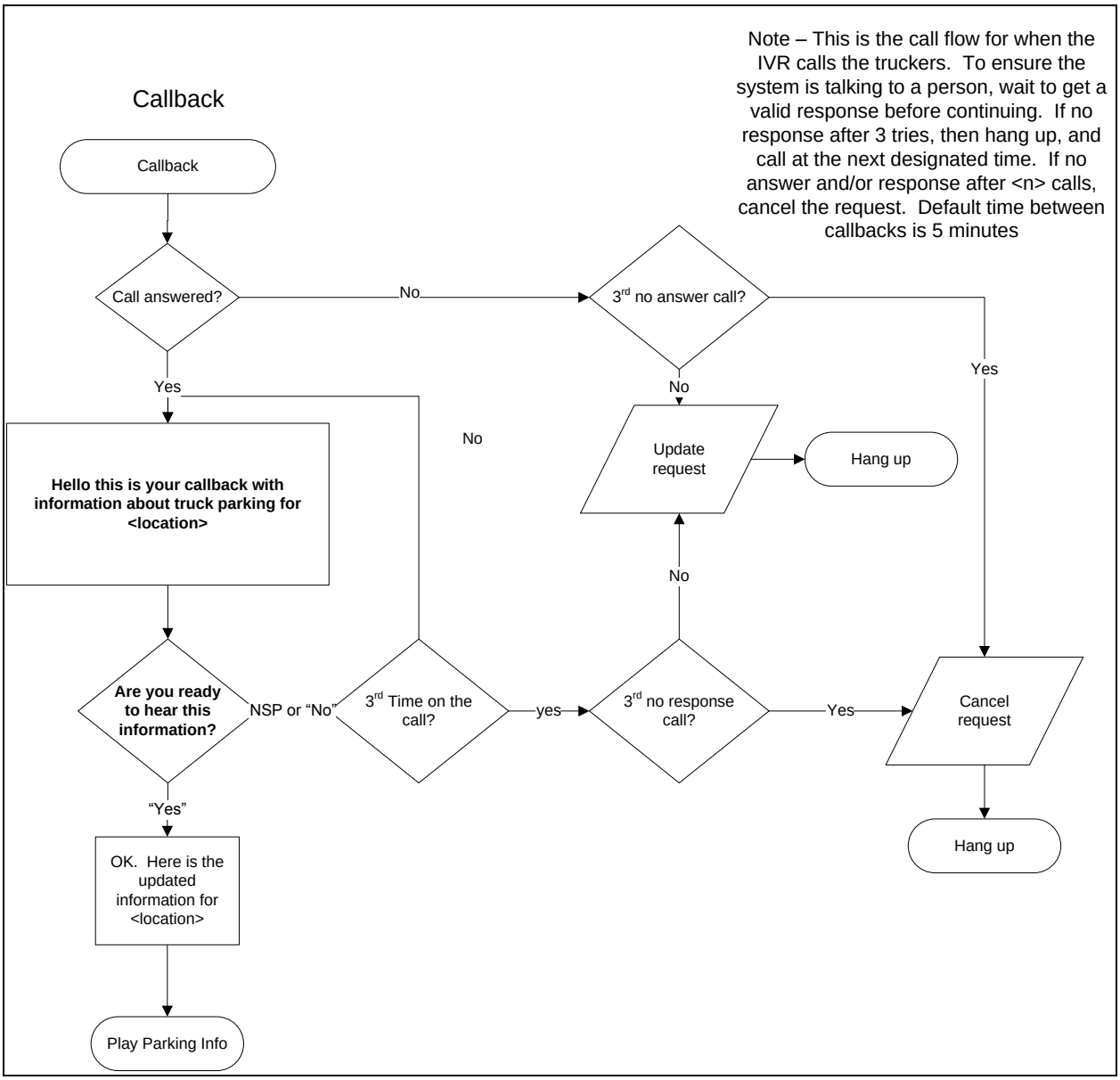
The prompt and grammar will reflect whichever type of location has been chosen. For example, if the user has chosen "Cities", the prompt will say "by saying the name of the City you'd like" and the grammar will only contain Cities.


Play Parking Information
Play Parking Info
Parking info Available?
No
# of Lots available
>1
1
I have information on "x" parking Lots. You can say "stop" or "Next Lot" at any time
Sorry no information is available right now
Get Lot and space info
Note: The IVR will use the phrase "At least n spaces, when only partial coverage is available, and the partial coverage indicates at least one space is available.
If the lot is offline, the IVR will indicate no parking information is available
"As of <hh:mm> at <parking lot>, <location> there are n spaces available."
"stop"
"call me back"
Call Me Back
"next lot"
Would you like more info on this lot?
Yes
PlayLotInfo
no
More Parking Lots ?
yes
B
no
"That's all I have right now."
PostPlayLotInformation

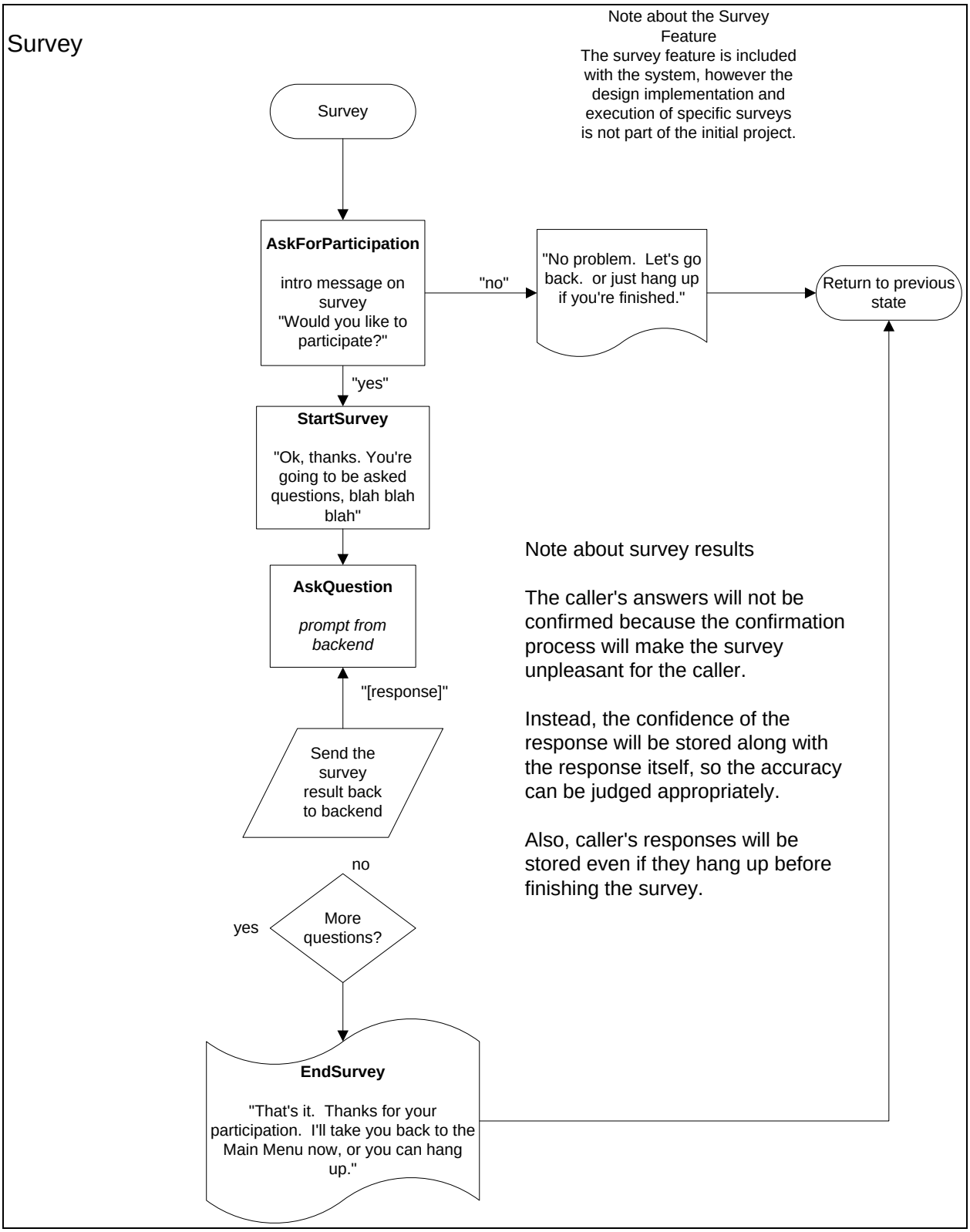

Post Play Lot Information
PostPlayLotInformation
Note: While the survey feature is available, the project does not include the definition and set up of any surveys
Is the survey feature on?
yes
Survey
no
Lot information available?
No
Yes
If you want to be called back with updates on this location, say “Call me back”
To repeat that information, say “Repeat”
For parking information for another location, say
(tier 1) Baltimore New York or a lot name
Just hang up if you are done, or say main menu
Area/Lot name
C
"repeat"
PlayParking Information
“Call Me Back”
"main menu"
CallMeBack
MainMenu


Play Lot Info
Play Lot Information
"<Parking Lot> is located at <address>.
The lot has the following features: <features>.
Phone Number available?
No
Yes
Would you like to Be transfered to the lot?
No
Yes
I'll transfer you to the parking lot, unless you say stop or press 1
"Stop"
"Okay, stopped..."
B
NSP
Transfer to parking lot


Call Me Back
Call Me back
Outstanding Request?
No
Yes
You already have an outstanding request to play information about <lot or area name> for <date/time> Would you like to keep it, change it or cancel it"
"Cancel it"
"Change it"
lot requested on this call?
No
You need to request parking information before you can be called back
Find Parking
Yes
Caller ID Available for callback ?
No
Shall I call you back in 15, 30 or 60 minutes ?
User Request
Store request
"Your caller id is blocked. In order for me to call you back, I need your number.
Say or type in your 10 digit phone number. One other option is to hang-up, unblock your caller id and call back.
Yes
"Keep it"
Valid Phone #?
No
Any digits?
Yes
I'm sorry <entered digits> is not a valid phone number
Yes
I'm sorry I didn't get that
Say or type in your 10 digit phone number.
Is the call a Callback?
No
OK. The number I will call you back on is <<phone number>.
yes
No
Is that correct?
yes
Shall I call you back in 15, 30 or 60 minutes ?
User Selection
Store request
Got it! You can hang up now, or hang on for more options
NSP
Main Menu

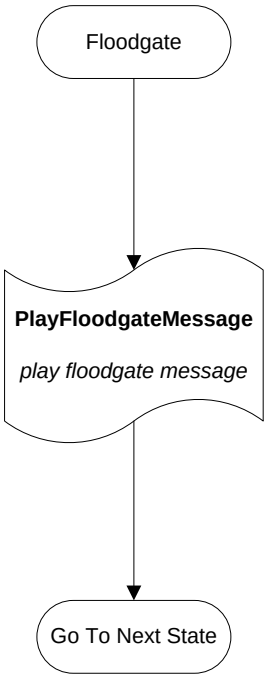

Callback
Callback
Note – This is the call flow for when the IVR calls the truckers. To ensure the system is talking to a person, wait to get a valid response before continuing. If no response after 3 tries, then hang up, and call at the next designated time. If no answer and/or response after <n> calls, cancel the request. Default time between callbacks is 5 minutes
Call answered?
No
3rd no answer call?
Yes
Yes
No
No
Update request
Hang up
Hello this is your callback with information about truck parking for <location>
No
Are you ready to hear this information?
NSP or "No"
3rd Time on the call?
yes
3rd no response call?
Yes
Cancel request
"Yes"
Hang up
OK. Here is the updated information for <location>
Play Parking Info

Survey


Note about the Survey Feature
The survey feature is included with the system, however the design implementation and execution of specific surveys is not part of the initial project.
Survey
AskForParticipation
intro message on survey
"Would you like to participate?"
"no"
"No problem. Let's go back. or just hang up if you're finished."
Return to previous state
"yes"
StartSurvey
"Ok, thanks. You're going to be asked questions, blah blah blah"
AskQuestion
prompt from backend
"[response]"
Send the survey result back to backend
no
yes
More questions?
EndSurvey
"That's it. Thanks for your participation. I'll take you back to the Main Menu now, or you can hang up."
Note about survey results
The caller's answers will not be confirmed because the confirmation process will make the survey unpleasant for the caller.
Instead, the confidence of the response will be stored along with the response itself, so the accuracy can be judged appropriately.
Also, caller's responses will be stored even if they hang up before finishing the survey.

Floodgate Messages

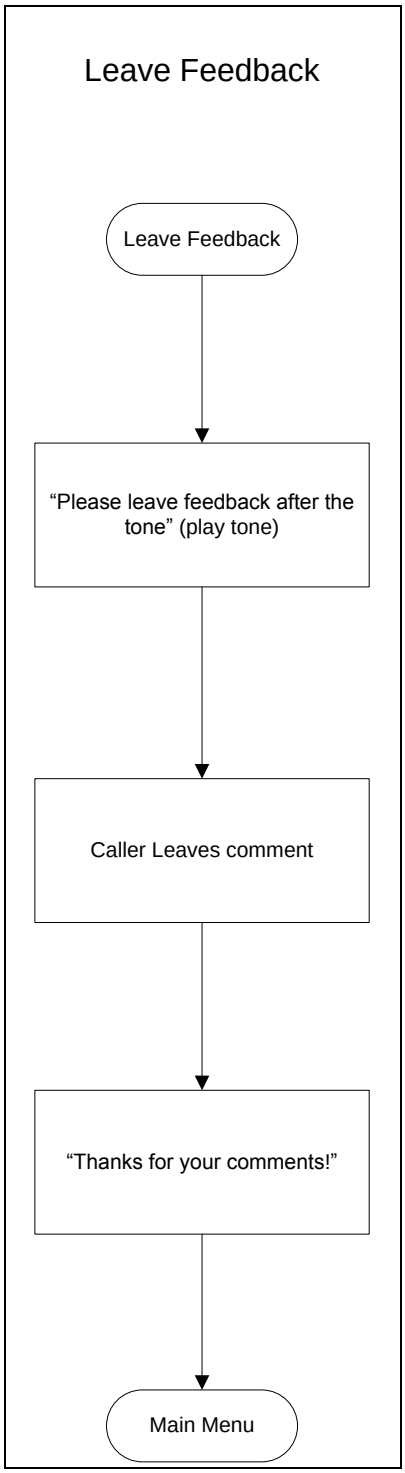
The floodgate feature is part of the application. However, the task of maintaining floodgate messages is not in the initial phase

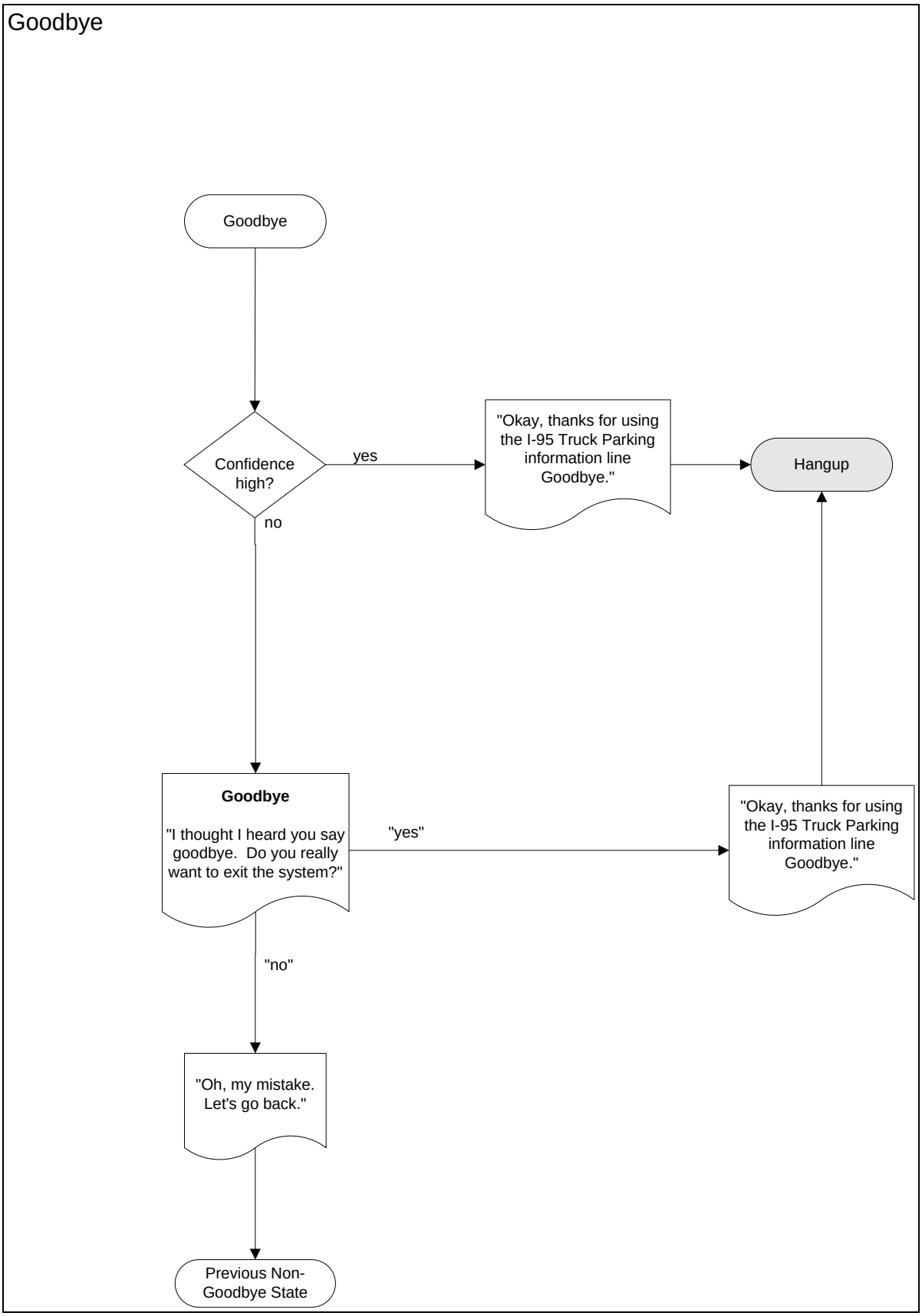


Notes on Floodgate Messages

Floodgate messages are temporary, important announcements that can be played in all menus in the application. They are configurable, so that the caller can or cannot barge-in depending on the defined configuration for a specific floodgate message. If a floodgate is active for a particular point, the prompt to be played is retrieved from the back-end. After the prompt is played, the application continues as normal.

Floodgates can be played at the start of any menu in the application.
.


Leave Feedback
Leave Feedback
"Please leave feedback after the tone" (play tone)
Caller Leaves comment
"Thanks for your comments!"
Main Menu


Goodbye
Goodbye
Confidence high?
yes
"Okay, thanks for using the I-95 Truck Parking information line Goodbye."
Hangup
no
Goodbye
"I thought I heard you say goodbye. Do you really want to exit the system?"
"yes"
"Okay, thanks for using the I-95 Truck Parking information line Goodbye."
"no"
"Oh, my mistake. Let's go back."
Previous Non-Goodbye State

Appendix E. External Data Feed Example

The following is an example XML message produced from the TPLS Parking Data Export application described in Section 5.3, External Data Feed, followed by a description of the file. Actual field population depends on information customized for each parking facility. Information from one or multiple facilities (<parkingLot>) can be supplied in a single message.

```
<?xml version="1.0" encoding="UTF-8" standalone="no" ?>
- <atis:advisoryInformation xmlns:atis="http://www.ATIS-Draft-03-00-79"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:schemaLocation="http://www.ATIS-Draft-03-00-79 ATIS-Draft-03-00-79.xsd">
- <responseGroup>
- <parkingLot>
- <head>
  <updateTime>2014-03-14T11:55:04Z</updateTime>
    </head>
- <location>
  <locationName>Ladysmith Safety Rest Area</locationName>
- <pointLocation>
- <geoLocationPoint>
  <latitude>37.98022</latitude>
  <longitude>-77.49192</longitude>
    </geoLocationPoint>
    </pointLocation>
    </location>
  <parkingFacID>100</parkingFacID>
  <parkingType>1</parkingType>
- <lotDetail>
  <spacesTotal>40</spacesTotal>
  <availability>34</availability>
- <spaces>
  <parkingArea>LS_001</parkingArea>
  <parkingAreaName>Lot 1</parkingAreaName>
  <type>1</type>
  <spaces>16</spaces>
  <availability>14</availability>
  <offlineSpaces>0</offlineSpaces>
  <unknownSpaces>0</unknownSpaces>
  <occupiedSpaces>2</occupiedSpaces>
    </spaces>
- <spaces>
  <parkingArea>LS_002</parkingArea>
  <parkingAreaName>Lot 2</parkingAreaName>
  <type>1</type>
  <spaces>24</spaces>
  <availability>20</availability>
  <offlineSpaces>0</offlineSpaces>
  <unknownSpaces>0</unknownSpaces>
  <occupiedSpaces>4</occupiedSpaces>
    </spaces>
  <lot-Name>Ladysmith Safety Rest Area</lot-Name>
    </lotDetail>
    </parkingLot>
    </responseGroup>
```

```
</atis:advisoryInformation>
```

File description:

<responseGroup> contains all parking lots

- <parkingLot> contains an individual parking lot
  - <head> is the parking lot header
    - <updateTime> is the last time the information for the parking lot was updated
  - <location> contains information about the location of the parking lot
    - <locationName> is the name of the parking lot
    - <pointLocation> contains the geographic location of the parking lot
    - <geoLocationPoint> contains the latitude and longitude of the parking lot
    - <latitude> and <longitude> are the physical coordinates of the parking lot
    - <parkingFacID> is the internal ID of the parking lot
  - <parkingType> is the type of parking lot. The only value currently used is 1, for Trucks
  - <lotDetail> contains the details of parking space availability of the parking lot
    - <spacesTotal> is the total parking spaces in the parking lot
    - <availability> is the total parking spaces available at the current time
    - <spaces> contains information about areas within the parking lot
      - <parkingArea> is the internal ID of the parking area
      - <parkingAreaName> is the name of the parking area
      - <type> is the type of parking lot. The only value currently used is 1, for Trucks
      - <spaces> is the total number of parking spaces in the area
      - <availability> is the number of parking spaces that are currently available in the area
      - <offlineSpaces> is the number of parking spaces that have been taken off-line in the area
      - <unknownSpaces> is the number of parking spaces for which a status is not available in the area. This will usually be due to equipment failure
      - <occupiedSpaces> is the number of parking spaces that are currently occupied in the parking area
    - <lot-Name> is the name of the parking lot

Appendix F. Sample IVR Telephone System Scripts

On March 24, 2010, a focus group with premier drivers was held in Louisville, Kentucky to describe how the Truck Parking Location System would function and to solicit feedback. Part of the meeting involved a reading of sample scripts for the IVR telephone system that demonstrated how the system would operate for three different scenarios. The scripts for these readings are provided below.

I-95 CORRIDOR COALITION'S TRUCK PARKING PROJECT
OVER-THE-PHONE SCRIPTS:
SAMPLE DIALOGUE FOR SELECTED SCENARIOS
VERSION 2.0

SCENARIO 1: FIRST-TIME SYSTEM CALLER

System: Welcome to *Truck'N Park: The I-95 Commercial Truck Parking Location System*.

Main Menu. To find a parking space, say "Find Parking."

<2-second pause>

For a list of locations, say "List Locations." To be called back, say "Call Me Back." To leave a comment, say "Leave Feedback."

What can I do for you?"

Caller: Find Parking.

System: Please select one of the following areas:
- Southern New York State.
- New Jersey/Pennsylvania.
- Delaware/Maryland.
- Virginia/North Carolina.

To hear a list of parking lots, say "List All."

Caller: List All.

System: OK, here's the list of lots. You may interrupt me at any time by saying the name of the lot you want, or say "stop."
- Flying J in Carney's Point, New Jersey.
- Delaware House Service Area in Brookside, Delaware.
- Baltimore T/A in Baltimore, Maryland.
- Baltimore South T/A in Jessup, Maryland.

Caller: (Interrupting) Baltimore T/A.

System: Baltimore T/A.
As of 9:30 PM, at Baltimore T/A in Baltimore, Maryland, there are 19 spaces available.

Would you like more information about this lot?

Caller: Yes.

System: Here is more information about Baltimore T/A. You can always interrupt me by saying "Stop" or "Next Lot."
- The lot is located off of Exit 57 on I-95, North or South.

The lot has the following features:

- 181 total spaces.
- 3 truck service bays.
- 11 showers.
- 8 fuel dispensers.
- On-site restaurant.
- Truck scales.
- Pronto Pass.
- Truck wash
- WiFi is available.
- Laundry room.

Caller: "Stop."

System: OK. Stopped. Would you like directions to this lot?

Caller: OK.

System: Here are directions to Baltimore T/A:

- From I-95 North or South, take Exit 57 and follow the signs to the truck stop.

Say "Repeat" to hear these directions again.

<Silence>

That's all I have right now. If you want to be called back with updates for Baltimore T/A, say "Call Me Back."

To repeat all the information for this lot, say "Repeat."

For parking information for another location, say:

- Southern New York State.
- New Jersey/Pennsylvania.
- Delaware/Maryland.
- Virginia/North Carolina.

Or say a lot name.

Hang up if you are done, or say "Main Menu."

Caller: Call Me Back.

System: OK, the number I will call you back on is 301-555-1234.
Is this correct?

Caller: Yup.

System: OK. Shall I call you back in 15, 30, or 60 Minutes?

Caller: In one hour.

System: Got it! I will call you back in 60 minutes with updated information on the Baltimore TA parking lot.

You may hang up now or hold on for more options.

Caller: <Hangs up>

SCENARIO 2: SYSTEM CALL-BACK

<Phone Rings>

Driver: (Picks up via hands-free mode.) Hello.

System: Hello. This is the *Truck'N Park* call-back service with information about truck parking for Baltimore T/A.

Are you ready to hear this information?

Driver: What is this?

System: Hello. This is the *Truck'N Park* call-back service with information about truck parking for Baltimore T/A.

Are you ready to hear this information?

Driver: Yes.

System: As of 10:30 PM, at Baltimore T/A in Baltimore, Maryland, there are 2 spaces available.

Would you like more information about this lot?

Driver: No.

System: That's all I have right now. If you want to be called back with updates for Baltimore T/A, say "Call Me Back."

To repeat that information, say "Repeat."

For parking information for another location, say:

- Southern New York State.
- New Jersey/Pennsylvania.
- Delaware/Maryland.
- Virginia/North Carolina.

Or say a lot name.

Just hang up if you are done, or say "Main Menu."

Driver: Virginia/North Carolina.

System: OK, Virginia/North Carolina. I have information on 3 lots.

As of 10:31 PM, at Pilot Travel Center in Colonial Heights, Virginia, there are 8 spaces available.

Would you like more information about this lot?

Driver: Nope.

System: As of 10:31 PM, at Richmond Travel Center in Ashland, Virginia, there are 0 spaces available.

Would you like more information about this lot?

Driver: No.

System: As of 10:31 PM, at Flying J Travel Plaza in Ruther Glen, Virginia, there are 10 spaces available.

Would you like more information about this lot?

Driver: No.

System: That's all I have right now. If you want to be called back with updates on this location, say "Call Me Back."

To repeat that information, say "Repeat."

For parking information for another location, say:

- Southern New York.
- New Jersey/Pennsylvania.
- Delaware/Maryland
- Virginia/North Carolina.

Or say a lot name.

Just hang up if you are done, or say "Main Menu."

Caller: <Hangs up>

SCENARIO 3: EXPERIENCED SYSTEM CALLER

System: Welcome to *Truck'N Park: The I-95 Commercial Truck Parking Location System*.

Main Menu. To find a parking spot, say "Find Parking."

<2-second pause>

For a list of locations, say "List Locations."

Caller: (Interrupting) Delaware/Maryland.

System: OK, Delaware/Maryland. I have information on 3 lots.

As of 10:45 PM, at Maryland House Welcome Center in Aberdeen, Maryland, there are 22 spaces available.

Would you like more information about this lot?

Caller: No.

System: As of 10:45 PM, at Baltimore TA in Baltimore Maryland, there are 10 spaces available.

Would you like more information about this lot?

<Silence>

As of 10:45 PM, at Baltimore South T/A South in Jessup, Maryland, there are 0 spaces available.

Would you like more information about this lot?

Caller: <Hangs up>

Appendix G. Acronyms

ANSI	American National Standards Institute
APCC	Access Point Controller Card
API	Application Programming Interface
ATIS	Advanced Traveler Information System
BPSK	Binary Phase Shift Keying
CCTV	Closed-Circuit Television
CDMA	Code Division Multiple Access
CGI	Common Gateway Interface
CLI	Command Line Interface
CORBA	Common Object Request Broker Architecture
COTS	Commercial Off-the-Shelf
DBMS	Database Management System
DTMF	Dual Tone Multi-Frequency
EDGE	Enhanced Data Rates for Global Evolution
ERD	Entity Relationship Diagram
EVDO	Evolution Data Optimized
FAQ	Frequently Asked Question
FCC	Federal Communications Commission
FHWA	Federal Highway Administration
FTP	File Transfer Protocol
GPRS	General Packet Radio Service
GPS	Global Positioning System
GSM	Global System for Mobile Communications
GUI	Graphical User Interface
HAR	Highway Advisory Radio
HSPDA	High Speed Downlink Packet Access
HSUPA	High Speed Uplink Packet Access
HTML	Hypertext Markup Language
HTTP	Hypertext Transfer Protocol
HTTPS	Hypertext Transfer Protocol Secure
IDL	Interface Definition Language
IEEE	Institute for Electrical and Electronics Engineers
IP	Internet Protocol
ISAKMP	Internet Security Association and Key Management Protocol
ISP	Internet Service Provider
ITS	Intelligent Transportation System
IVR	Interactive Voice Response
JDBC	Java Database Connectivity
JMS	Java Messaging Service
JNDI	Java Naming and Directory Interface
JPEG	Joint Photographic Experts Group
KVM	Keyboard-Video-Mouse
LDAP	Lightweight Directory Access Protocol
MJPEG	Motion JPEG

MPEG	Motion Picture Experts Group
NCD	Nuance Call Distributor
NDS	Novell Directory Service
NEMA	National Electrical Manufacturers Association
NSP	No Speech Timeout
NTCIP	National Transportation Communications for ITS Protocol
NTSC	National Television System Committee
O&M	Operations and Maintenance
ODBC	Open Database Connectivity
OFDM	Orthogonal Frequency Division Multiplexing
OI	Operator Interface
PAL	Phase Alternate Line
PDE	Parking Data Export
PGS	Parking Guidance System
POI	Point of Interest
PTZ	Pan-Tilt-Zoom
QoS	Quality of Service
QPSK	Quadrature Phase Shift Keying
RAID	Redundant Array of Independent Disks
REST	Representational State Transfer
SCEP	Simple Certificate Enrollment Protocol
SMTP	Simple Mail Transfer Protocol
SNMP	Simple Network Management Protocol
SQL	Structured Query Language
TCP/IP	Transmission Control Protocol/Internet Protocol
TELCO	Telephone Company
TMDD	Traffic Management Data Dictionary
TPLS	Truck Parking Location System
TTS	Text-to-Speech
UML	Unified Modeling Language
UMTS	Universal Mobile Telecommunications System
UPS	Uninterruptible Power Supply
URL	Uniform Resource Locator
USB	Universal Serial Bus
VM	Virtual Machine
VOIP	Voice over Internet Protocol
VPN	Virtual Private Network
WAN	Wide Area Network
XML	Extensible Markup Language
XSD	XML Schema Definition