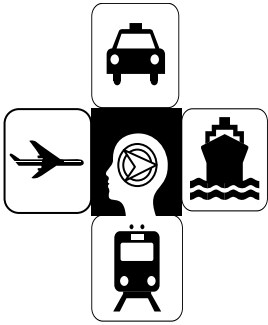


JERSEY DOT'S

"TURNING PROBLEMS INTO SOLUTIONS"



Tech Brief

Technical Solutions to Park and Ride Facilities

Need a solution?

FHWA-NJ-2007-011

June 2007

SUMMARY

The thrust of this project is the establishment of a Parking Information and Reservation System (PIRS) for New Jersey Department of Transportation (NJDOT) that will incorporate the Park & Ride (P&R) facilities within its functional operations such as the NJDOT's North and South traffic control centers. Each of these centers will be responsible for the *communication and parking space detection system* at each facility. The advantage of incorporating the functionality and operation of P&R facilities with the existing traffic control centers are the *economies-of-scale* that will be achieved through the use of the knowledge of the transportation network that has been accumulated and the use of the same traffic surveillance/communication infrastructure. The NJDOT PIRS should be federated with the main transit operators of the region, including New Jersey Transit (NJT) and private operators, private parking lot operators, and traveler information providers (Transportation Coordinating Committee (TRANSCOM) TRIPS123, NJT's telephone and web service, other).

The principal components of a PIRS include: 1) Traffic flow monitoring system of the traffic flow conditions, the P&R traffic facility conditions, and the bus/train schedule and routing conditions; 2) a Parking Guidance and Information System (PGIS); 3) a PIRS communication system between the P&R facilities, the PGIS sub-system, the PIRS operations and information center, various traveler information service providers and transportation operations centers; 4) a PIRS operations and information center that will include a data management system including data warehousing, route planning algorithms, traffic flow estimation and prediction, parking occupancy estimation and prediction, parking reservation and intermodal transportation planning models.

Several models were developed in this study that include: parking reservation algorithms, a web-based and cellular based parking information and reservation system called Mobile Parking Assistance, Information and Reserve System (MPAIRS), and a P&R static intermodal transportation planning model.

The report includes a literature review of traffic monitoring technologies and a limited cost comparison analysis of Inductive Loop Detectors Systems (ILDS), Microwave Radar Detection Systems (MRDS) and Video Image Processing Detection System (VIDS). Based on the cost analysis the Dual Axis Magnetometer provides the least costly technology if the only function desired is a counting system of the number of P&R arrivals and departures.

The report provides a review of Radio Frequency Identification (RFID) technologies and their potential capabilities. The cellular phone is becoming the main technology that travelers currently utilize to send and receive information. NJDOT could establish a PIRS service that will be based on cellular telephony and provide timely information for its P&R program, P&R location, routing, and in the future, real-time parking space occupancy and routing information.

INTRODUCTION

This report summarizes the results of the work performed under the project *Technical Solutions to Overcrowded Park and Ride Facilities*. The New Jersey Department of Transportation (NJDOT) is continuing to improve its Park and Ride (P&R) program as the demand for new facilities increases or decreases due to various changes in the demographics and travel characteristics of a region in New Jersey. Currently the NJDOT operates a successful P&R program that covers over 80 P&R facilities over the state. However, some P&R facilities are overcrowded and some are underutilized. The NJDOT's goal is to maximize the utilization of the P&R facilities in order to reduce highway congestion and to provide mobility to people who cannot travel long distances with an automobile. The goals of the research project were to respond to the needs of the NJDOT relative to:

- Improving the operation and efficiency of the present P&R system.
- Identifying potential technological solutions that could address the issue of anticipated demand for P&R parking - overcrowding or underutilization of various facilities.

RESEARCH APPROACH

This project provides a review of potential technologies and makes recommendations on those that could contribute to an efficient management and operation of NJDOT's P&R facilities. The main technologies surveyed include: 1) Technologies to monitor in real time the parking space availability, 2) Technologies to provide P&R information to travelers, 3) Technologies to provide parking reservation to travelers, and 4) Development of a prototype intermodal transportation planning model that could be used to analyze the location and capacity of a set of P&R facilities. These technologies are summarized next:

The principal elements of a comprehensive NJDOT P&R program may include:

1. A statewide Parking Information and Reservation System (PIRS).
2. A Planning, Management and Operations System (PMOS).

PARKING INFORMATION AND RESERVATION SYSTEM (PIRS)

A PIRS system should include the following components: a real-time P&R traffic and transit monitoring and data management system, and a communication system,

Monitoring and Data Management System

Monitoring

The monitoring system could include the following sub-systems: traffic flow monitoring of the transport network, traffic flow monitoring of the vehicles entering and exiting each P&R facility, and visual inspection and video monitoring of the P&R facility and its surroundings.

Traffic flow monitoring of the transport network – This will produce estimates of traffic flow conditions on and at all main arterial links and intersections, respectively, of the transport network per time period of the day, day of the week and special days, with all detectors connected to the existing NJDOT North and South transport operations centers. Such a system will provide the basis for the establishment of real-time traffic forecasting, plus a comprehensive intermodal transportation planning model for NJDOT

P&R traffic flow monitoring system - This will produce estimates and predictions of the number of free parking spaces. Such a system would require the installation of ingress and egress detectors at each P&R facility, covering all exits and entrances. A full-fledged system should be able to produce *real-time estimates of the parking occupancy* by detecting the number of vehicles entering and exiting each facility per time period of the day. A *maximum 15-minute time period* is recommended in order to provide timely parking occupancy information to travelers. In addition, each ingress and egress detector should be connected to a wireline or wireless communication system to either a local controller or a central computer for real-time analysis.

An essential element of the P&R traffic monitoring system is a data management system that will store the data in a data warehouse where it could be used for real-time and off-line analyses.

Real-time transit monitoring system - A *real-time monitoring system of the transit* (bus and rail) servicing each P&R facility is necessary to provide timely reports to the transit operators and the travelers.

Monitoring of the P&R facility and its surroundings – The periodic monitoring and/or video surveillance of each P&R facility is necessary in order to provide reports on the status of the various features of each facility and to enhance safety. Continuous surveillance can be accomplished through a Closed Circuit Television (CCTV) system covering the P&R surroundings.

Data Management System

A new P&R facility database was developed as part of this study that could be used as a basis of a future Park & Ride- Data Management System (PR-DMS). The main elements of this database are: 1) P&R Facility Ownership, Management and History, 2) P&R Facility

Infrastructure Characteristics, 3) P&R Historical Operational and Safety Database, 4) Transit Services Provided in the

Communication System

A wireless and wire line communication system between the parking lot facilities, the Parking Guidance Signs (PGS), the PIRS operations center and the travelers, is proposed. NJDOT could leverage its existing communication system that is in place at the North and South Jersey transportation operations centers and integrate the P&R facilities' monitoring system to either of them. In addition, the P&R communication system should be connected to other traveler information providers, including TRANSCOM's TRIPS123 and NJT.

PLANNING, MANAGEMENT AND OPERATIONS SYSTEM (PMOS)

P&R Intermodal Transportation Planning Model - The NJDOT currently maintains and continuously upgrades two transportation planning models, the North Jersey and the South Jersey models. The current models are based on static traffic assignment (STA) and do not include intermodal characteristics. These models could be enhanced to incorporate the P&R facilities of NJDOT, NJT and other private parking lots. A P&R intermodal transportation planning model would be used to evaluate and optimize the location, capacity of P&R facilities and schedule/routing of the bus and rail services, and the location and function of Parking Guidance Signs (PGS) signs.

Parking Equilibrium Model - A parking equilibrium model was also developed as part of this study in co-operation with The Transportation Information and Decision Engineering (TIDE) center at New Jersey Institute of Technology (NJIT). This model provides an analytical representation on the competition between parking lot facility owners serving a specific geographical area.

The parking space pricing between parking facility owners and travelers was formulated as an asymmetric spatial price equilibrium variational inequality (VI) problem. The parking facility owners and the travelers, who want to park at a specific geographic area, reach an equilibrium that is based on the functional form of the respective parking supply price and the user group demand price. No attempt was made in this study to identify the form of the supply and demand price functions. The supply, demand, and transaction costs are defined as functions of the corresponding supply parking spaces of all the competing parking facilities, user demand groups, and link flows, respectively. The necessary conditions to produce a unique solution are provided also.

An algorithm has been developed based on the barrier method that forces the solution to stay in the feasible region, which is the first implementation of this method to solve VI problems. The algorithm was implemented on two small parking problems and showed very promising results.

To produce a more comprehensive model inclusive of the network characteristics and traffic conditions in the estimation of the corresponding supply, demand, and transaction costs, the parking equilibrium problem should be further integrated into the intermodal-planning model developed in this study.

POTENTIAL TECHNOLOGIES

Parking Space Monitoring Technologies - A summary of some popular vehicle sensing technologies that could be used for parking applications, as well as other rather new technologies, was undertaken as part of this study. This review concentrated mostly on the following technologies: 1) Inductive Loop Detections Systems (ILDS), 2) Video Image Detection Systems, 3) Dual Axis Magnetometers (DUA), and 4) Radio Frequency Identification (RFID) based detection systems.

PIRS Web Site - The study specifies a Web-site for NJDOT's PIRS system that will provide real-time or historical P&R information with regards to facility location, directions, historical/real-time parking occupancy, transit schedule, safety information, parking cost and payment, and bicycle related information. This web site should be integrated or federated with New Jersey Transit's (NJT) and the Transportation Coordinating Committee (TRANSCOM) Corporation's traveler information service (TRIPS123 – www.xcm.org).

PIRS Parking Reservation System (PRS) - One potential technology that could be used for the P&R system is a PRS system for all or some P&R facilities. PRS aims to reduce the congestion associated with the search for parking and the associated driver frustration, by providing the travelers the capability to reserve a parking space within the vicinity of their destination. A first call first serve based system could be implemented that will provide assurance for some travelers that a parking space is available for them. Such a system is recommended to be accompanied with an associated parking payment system. As part of this study a PRS system was developed that could be used to support a cluster of P&R facilities based on the minimization of the system wide user cost (parking cost plus the generalized travel cost from the travelers' origin to the parking facility).

Cellular-based PIRS system Mobile Parking Assistance, Information and Reservation System (MPAIRS) - A prototype cell phone based PIRS system was developed whereby travelers can receive P&R information, make a reservation and receive routing directions. This prototype, called the MPAIRS, was also co-developed in cooperation with the TIDE center at NJIT.

Operational PRS - An operational PRS could be implemented for P&R facilities by considering the travel time (cost) of each traveler from his/her origin (e.g. house) to the facilities that serve the bus or train routes that serve the user's destination (e.g. office).

RECOMMENDATIONS

Proposed Interim Steps for the establishment of a PIRS - The following interim steps will aid the NJDOT while it implements a fully functional PIRS system:

Step 1 - Conduct periodic parking occupancy surveys for all P&R facilities and record the number of free spaces available for each time period of the day; enhance the existing P&R data warehouse system; establish a PIRS web-site; and report the results on the NJDOT P&R web-site.

Step 2 – Install traffic detectors and a communication system for some or all P&R facilities that reach capacity during the day based on budget availability; establish a real-time data management system; report the *parking occupancy* and the *probability of finding a free parking space* for each facility on NJDOT’s PIRS web-site and/or the TRIPS123 traveler information service and/or NJT web-site; and establish a telephone and email service for PIRS subscribers and send information through SMS and/or email.

Step 3 – Enhance the existing PGIS system with more PGS signs; and conduct a feasibility study on the establishment of a PGIS that will include dynamic signs and its incorporation to the PIRS.

Step 4 – Develop a DTA-based state-wide Intermodal Transport Planning and Operations model that will be used for planning purposes.

Step 5 – Establish a real-time traffic PIRS system for the state of New Jersey in collaboration with TRANSCOM, NJT and other transportation operation centers, transit providers and traveler information service providers of the region; incorporate one or more of the data processing algorithms outlined under the PIRS, including a Dynamic Traffic Assignment (DTA)-based traffic forecasting system, parking occupancy estimation/prediction and travelers’ routing algorithms to/from the P&R facilities.

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A final report is available online at
<http://www.state.nj.us/transportation/refdata/research/>

If you would like a copy of the full report, please FAX the NJDOT, Bureau of Research, Technology Transfer Group at (609) 530-3722 or send e-mail to Research.Bureau@dot.state.nj.us and ask for:

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