

Intelligent Transportation Systems Technology for Public Transit

Conference Proceedings

May 19, 2004

Sponsored by:

University Transportation Research Center, Region II

City College of New York

New Jersey Department of Transportation

The Graduate Center, City University of New York

U.S. Department of Transportation



About the Conference

Public transit is benefiting greatly from Intelligent Transportation Systems (ITS). But the rapid pace of improvements in technology has in many cases outrun the ability of operating agencies, government, academia, and the private sector to determine how best to implement and manage these technologies, and how their full benefits can be realized. The purpose of this conference was explore unanswered questions about the application of ITS technologies in public transit, with the goal of developing an agenda for future research and university-government-industry cooperation on these issues.

The conference was held on May 19, 2004, in the Harold M. Proshansky Auditorium at the Graduate Center of the City University of New York. There were over 100 participants, including researchers, students, developers, engineers, managers, and decision makers from state and local governments, transportation operating agencies, labor unions, academic research centers, and the private sector.

The conference was organized by Camille Kamga and Robert Baker of the University Transportation Research Center, with the very helpful assistance of David Levine, Director of Continuing Education and Public Programs at the Graduate Center of the City University of New York. It was co-sponsored by the New Jersey Department of Transportation and the U.S. Department of Transportation. Other participating organizations included the Port Authority of New York and New Jersey, New Jersey Transit, MTA New York City Transit, New York State Department of Transportation, TWU Local 100-NYCTA Training and Upgrading Fund, and the U.S. Department of Transportation. These proceedings were written by H. James Kinoshita and Chris Andrichak. They were edited by Todd Goldman, with the assistance of Satwant Singh.

Thanks are especially due to the New Jersey Department of Transportation and the Research and Special Projects Administration of the U.S. Dept. of Transportation for funding the publication and dissemination of this document.

Viewpoints expressed in this document do not necessarily reflect those of UTRC or the conference sponsors.

About UTRC

The Region 2 University Transportation Research Center (UTRC) is one of ten original University Transportation Centers established in 1987 by the U.S. Congress. These Centers were established with the recognition that transportation plays a key role in the nation's economy and the quality of life of its citizens. University faculty members provide a critical link in resolving our national and regional transportation problems while training the professionals who address our transportation systems and their customers on a daily basis. UTRC includes a dozen participating universities in New York, New Jersey, and Puerto Rico, and is led by Prof. Robert E. Paaswell, Distinguished Professor of Civil Engineering at the City College of New York.

Table of Contents

<i>Key Acronyms</i>	1
<i>Introduction</i>	3
Robert E. Paaswell, Director, University Transportation Research Center, Region II	
<i>Welcoming Remarks</i>	4
John C. Falcocchio	
<i>Vision Statement</i>	5
New Paradigms for Local Public Transportation Organizations – Robert G. Stanley	
<i>Panel 1: Best Practices</i>	7
Uses of AVL and APC Technologies at TriMet: – Thomas J. Kimpel	
Evaluation of Garden State Parkway Alternate Bus Routing Project – Kaan M.A. Ozbay	
Inter-Vehicle Communications – Tarek N. Saadawi	
Best Practices in Building ITS Network Infrastructure – Damian McShane	
<i>Panel 2: Local Conditions</i>	11
ITS in Northern New Jersey – Michael F. Pilsbury	
ITS Technology at PATH – Frederick R. Childs	
Mapping the Underground City – Dan McHugh	
<i>Panel 3: Integration of ITS Technology</i>	14
ITS Standards for the Transit Industry – Jerome M. Lutin	
Why Integration? – Jim Davis	
Integration and the Workforce – Arthur Goldberg	
<i>Workshops</i>	17
Workshop 1: Operations and Maintenance	
Workshop 2: Safety and Security	
Workshop 3: Customer Support	
Workshop 4: Finance, Costs & Benefits	
<i>Speaker Biographies</i>	22

Key Acronyms

ALIS – Accident Location Information System, a project to develop a non-proprietary, geographically accurate base map of streets and landmarks in New York State.

APC – Automatic Passenger Counter, technology used provide real-time ridership and passenger loading data.

ATIS – Advanced Traveler Information Systems. The Society of Automotive Engineers is developing a standard message set and data dictionary for these applications that will supplement NTCIP with a greater emphasis on communications to travelers.

AVL – Automatic Vehicle Location, technology employed to pinpoint the location of transit vehicles such as buses.

CAD – Computer-Aided Design.

DMS – Dynamic Message Signs.

ITS – Intelligent Transportation System.

FTA – Federal Transit Administration.

GIS – Geographic Information System.

GPS – Global Positioning System.

GSP ABR – Garden State Parkway Alternate Bus Routing Project.

HAR – Highway Advisory Radio.

IEEE 1512 – Incident Management Communications Standards, developed by the Institute of Electrical and Electronics Engineers. This supplements NTCIP with an emphasis on the needs of highway emergency management centers.

ICT – Information and Communications Technology.

MTA – Metropolitan Transportation Authority.

NJDOT – New Jersey Department of Transportation.

NJSP – New Jersey State Police.

NJT – New Jersey Transit.

NTCIP – National Transportation Communications for ITS Protocol, developed by the National Electronics Manufacturers Association, the American Association of State Highway and Transportation Officials, the Institute of Transportation Engineers, and the Federal Highway Administration. This protocol establishes a common language for all ITS-related data communications.

NTD – The National Transit Database, a statistical database administered by the FTA.

NYCT – New York City Transit.

NYSDOT – New York State Department of Transportation.

PANYNJ – Port Authority of New York and New Jersey.

PATH – Port Authority Trans-Hudson Rapid Transit.

RTMS – Remote Traffic Microwave Sensor, a low-cost, general-purpose sensor that measures automobile traffic in multiple independent lanes.

TCIP – Transit Communications Interface Profiles, a component of the NTCIP that focuses on automated data exchange for public transit applications.

TMA – Transportation Management Associations.

TMDD – Traffic Management Data Dictionary, developed by the Institute of Electrical and Electronics Engineers and the American Association of State Highway and Transportation Officials. This supplements NTCIP with an emphasis on communications between transportation management centers.

TOC – Traffic Operations Center.

TRANSCOM – The Transportation Operations Coordinating Committee, a consortium of 16 agencies in the tri-state New York Metropolitan Area aimed at improving inter-agency response to traffic incidents.

TSP – Transit Signal Priority

USDOT – United States Department of Transportation.

VMS – Variable Message Signs.

Wi-Fi – “Wireless Fidelity” – high-frequency wireless local area network.

Introduction

*Robert E. Paaswell, Director, University Transportation Research Center, Region II
Distinguished Professor of Civil Engineering, City College of New York*

As the last millennium ended – less than 5 years ago – sending pictures casually by telephone, getting e-mail on your “Blackberry,” or finding a restaurant by using the screen on your car’s dashboard still seemed, if doable, a little like science fiction. Now all of these are becoming part of our daily routine. The rapid and accelerating integration of computers of all sizes – nano to macro – coupled with advances in information technology and communications have provided the most profound changes to every aspect of our daily lives. And to those growing up with these advances, the 25-and-unders, such advances are not spectacular, but normal. Their expectations of a quality of life, supported in part by instant access to information and colleagues are supported by the current and emerging state of art of these technological advances.

So – what about transit? An industry that had been somewhat trapped by practices existing post-World War II is beginning to embrace technological change. But, at the start of this millennium, the main question is, “What is driving the change?” Is it the technology or the transit properties themselves? As we have seen from the path-breaking study by TCRP of “New Paradigms,” this is an era of customers driving change in the industry. Innovative ways of meeting customer needs, and methods to measure the accomplishment of meeting those needs are now considered good business practices.

In 2004 transit properties have two objectives they must address. The first is to identify the needs of its 21st Century customer base, a different base from those customers it had in 1975. The second is to understand how the new technologies can help these objectives, and provide a service to those under-25’s noted above who are becoming and should remain their customer base.

These are tough questions. With 1/3 of the national transit base in our region – which is the UTRC Region¹ - these questions must be addressed. And what better forum than a University – Agency – Professional Practice forum. UTRC initiated this conference with the goal of identifying research needs to help the industry and the region begin to answer these questions. We invite the reader to review these proceedings and to correspond with us to further this important discussion.

Robert E. Paaswell

Director, UTRC and

Distinguished Professor of Civil Engineering, The City College of New York

¹ Region 2 of USDOT – New Jersey, New York, Puerto Rico and the Virgin Islands

Welcoming Remarks

John C. Falcocchio

Chair, Department of Transportation Planning, Polytechnic University

Director, TRI

Intelligent Transportation Systems have a potentially important contribution to make in improving mobility of travelers. These technologies are making a particularly strong impact in the public transit system, through enhanced traveler information services, more efficient systems operations and maintenance, new integrated management systems, and safety and security improvements. This conference will address each of these areas and will identify current and potential contributions of ideas for improving the quality of transit service.

Toward the end of the day, the conference will include four workshops. These workshops will focus on operations and maintenance, safety and security, customer support, and cost-benefit analysis and financing of ITS investments. These workshops will help produce the core product of this conference: a research agenda that can help the region achieve the full potential benefits of ITS investments. The workshops will be used to help identify areas where university faculty and their students, industry, and public agencies can work together to address unmet research needs. They will hopefully form a framework from which we can identify research areas for future years.

Vision Statement

New Paradigms for Local Public Transportation Organizations: The Central Role of Information Technology

Robert Stanley

The premise of TCRP's "New Paradigms" project has been that reinvention and fundamental change are necessary if public transit is to continue to thrive over the next ten years. Most public transit agencies are still working with the same organizational structures they have had for the past 40 years. In contrast, the private sector has evolved considerably during this time. Entirely new approaches and strategies in business organization emerged from an increased customer focus and reliance on information technology.

In the intermodal freight industry, the period between 1980 and 1985 was known as the 'logistics revolution.' Prior to this period, shippers were organized around modes of transportation. The effectiveness of the organizations was measured through the efficiency of each individual set of assets owned by the company. The 'revolution' took place as shippers realized that to maintain market share they had to shift strategic focus to the customer and the quality of the customer's experience. This new focus – in addition to the traditional interest in using assets efficiently – was accomplished by organizing, monitoring and reporting on the quality of the customer's full experience across modes.

This reorientation led to new strategic concepts – collaboration in how freight is handled and rationalization of assets and resources within and across companies. In the new organizational and business model, at the lowest level there is a series of capacity providers using a variety of assets and equipment to deliver freight to best meet customer needs. The providers of capacity are linked to customers through state-of-the-art information technologies. The new strategic focus of the company is in managing these logistics on behalf of the customer, rather than simply providing a single type of capacity on assets owned by the company. The information technology enables and induces this shift in strategic orientation. Examples of this new model can be seen in UPS where the customer gives a package to a manager, logistics are performed at a central point, and modal capacity may be outsourced; Fed Ex has signaled its intent to move in this direction as well. Within the airline industry, the formation of alliances among formerly competing airlines and the use of information technologies allow travelers to book their ticket with their preferred airline and flight capacity can be shared among alliance members to best meet customer requirements.

Another example of horizontal integration can be seen in the collaborative management of transit services in Gothenburg, Sweden. Demand-responsive services run by the local organizations originally had separate dispatching and management services. Information technology enabled systems of routing, dispatching, and tracking to be cost-effectively shared among the systems deploying varied equipment and assets. The new integrated service provider took this a step further by developing an automated dispatching program where clients with different travel requirements and program eligibility can engage the automated system, make their travel needs known, have a driver and vehicle assigned to the trip to minimize schedule disruptions to all riders, receive a confirmation and have the assigned trip communicated to the correct vehicle and driver.

These examples of the new paradigm for transit demonstrate the necessity of integrating and collaborating across organizations, institutions, and modes. This prompts the strategic focus of an organization to shift from managing assets to enhancing the quality of the customer experience. The critical enabler in each case is the employment of state-of-the-art information technology to centralize logistical functions from a customer standpoint while decentralizing accountability for service provision among many providers using a variety of assets and equipment.

Panel 1: Best Practices

Moderator: Eva Lerner-Lam, President, Palisades Consulting Group

This session identified the best practices in management, operations, maintenance, procurement and planning of ITS transit technologies in the region and the country. Best practices set good examples for other agencies, operators, vendors, services, academics, researchers, etc. They are something that can be and should be used by others and should be flexible and adaptable.

Budgets are constrained today; making it wasteful and counterproductive to continuously solve the same problems. Best practices are important because they keep you moving forward through information sharing. They start with people with good ideas and those who champion them.

Uses of AVL and APC Technologies at TriMet: The Case for Comprehensive Data Collection ***Thomas J. Kimpel, Research Associate, Center for Urban Studies, Portland State University***

Few transit agencies have been successful in fully integrating their various ITS technologies. It is not simply a question of providing bus location information to operations personnel and customers in real-time since much additional value centers on improved capabilities for off-line analysis of transit operations. Ideally, data collected through an agency's transit ITS system can be used to support internal decision-making related to other agency functions including scheduling, supervision, planning, and marketing. Relevant factors related to successful transit ITS implementation include 1) the extent of ITS technology deployment within agencies, 2) the level of aggregation of the collected data (e.g., poll or stop-based vehicle location data) and 3) the level of commitment by the agency in the areas of technology and staff resources to make use of data once it has been collected.

TriMet, a regional transit provider in Portland, Oregon, has equipped 100% of its bus fleet with automatic vehicle location (AVL) technology and 72% with automatic passenger counter (APC) technology. The AVL system was implemented during lean budget times as an integral part of the larger Bus Dispatch System upgrade that became fully operational in 1998. TriMet "smart buses" are equipped with GPS antennas to transmit vehicle location at regular time intervals, radio antennas for two-way event data communication between operators and dispatch centers, and various sensors connected to an on-board computer that collect and store comprehensive information recorded at each stop.

One of the main strengths of TriMet's integrated ITS system is that archived, bus stop-level data can be used for off-line analysis of transit operations. Widespread APC coverage has enabled the agency to use automatically collected data for NTD reporting. TriMet no longer has to assign APC-equipped vehicles to specific trips for data collection purposes. Instead, they rely on ex post facto sampling of archived passenger data. AVL and APC data are being used to develop the "next generation" of transit performance measures. Notable examples include operator versus peer on-time performance and load-to-achievable capacity. Both the quality and quantity of AVL and APC data allow the agency to answer very specific research questions as well as undertake special-purpose studies. An example of the former includes examining whether headway maintenance problems are due to passenger or operator variability. Other agency efforts have focused on increasing schedule efficiency or improving system level on-time performance.

In the fall of 2002, TriMet implemented Transit Tracker, a system that provides real-time bus arrival forecasts to customers based on AVL data. It utilizes multiple communications technologies and is available in numerous display formats in the form of electronic displays at nearly all 10,000-plus bus and light rail transit stops, PC and PDA access through the Internet, and cell phone access. The goal of the system is to benefit customers primarily through the reduction of wait times at stops.

TriMet's work with AVL/APC data is commendable, but still represents only a part of a largely unexplored territory. Performance monitoring capabilities will undoubtedly continue to improve over time. Efforts are currently underway to support other ITS objectives (e.g., transportation management and traveler information) through regional data sharing. Additionally, future transit ITS technologies such as smart card-based electronic fare payment technology will provide much-needed passenger origin and destination information.

Evaluation of Garden State Parkway Alternate Bus Routing Project

Kaan M.A. Ozbay, Ph.D., Associate Professor of Civil Engineering and Associate Director of CAIT, Rutgers University

The Garden State Parkway Alternate Bus Routing (GSP ABR) Project was initiated after TRANSCOM began to provide information to help transit buses avoid traffic congestion on the New Jersey Garden State Parkway. A portion of these bus routes could bypass the congestion by exiting the Garden State Parkway and taking Route 9 as an alternative.

The GSP ABR system was tested using function and performance tests and system-wide performance tests. Functional and performance testing included evaluating bus routing, audio messaging, traffic volume data accuracy, and travel time data accuracy. System-wide performance testing involved an examination of bus travel time reduction and consumer satisfaction.

In addition, each of the system's algorithms was tested to see which one produced the shorter route. Actual travel times were tested using two cars, both instrumented like a bus, with one traveling on the Garden State Parkway and the other traveling simultaneously on an alternate route using a combination of the Garden State Parkway and Route 9.

There were lessons learned from this Alternate Bus Routing Project as a result of several problems that arose. Most of the problems were hardware-specific although most of the hardware was off-the-shelf and widely used. When testing was done, several calibration problems were found with the sensors and readers. Most of the problems were also site specific. For example, when the sensors and readers were not pointed in the correct direction, they would falsely inflate the volume of traffic. The accuracy of sensors depends heavily upon their appropriate installation and maintenance.

In the end, it was determined that the length of the diversion route was too short and that traffic conditions were generally very similar on both routes. The minimum requirement for travel time

savings by diverting buses (four minutes) could not be satisfied even during the morning rush hour commute. Customers' perceptions of the system were mixed.

Before implementing an ITS project, it is essential to talk to the users of the technology and to make sure that they understand the benefits of the system. In this case the project did not provide many quantifiable benefits to the users. It is also vital to make sure that the systems works as promised, keeping in mind not to downplay the benefits, but at the same time not to inflate them. Another issue to keep in mind is that network and traffic conditions play an important role in successfully testing and deploying any ITS technology.

Inter-Vehicle Communications

***Tarek N. Saadawi, Professor, Department of Electrical Engineering, City College of New York
Director, Center for Information Networking and Telecommunications***

Building a communications “infostructure” should be a top priority. In order for this infostructure to have maximum utility and minimal cost, it must fulfill several criteria. It will need to bring information and experiences to people anytime, anywhere, and in any form. It must always be on and easy to use with a seamless transparent medium in the form of voice and multi-media. To achieve wide appeal, it needs to be “self-service” and personalized.

The objective of developing an inter-vehicle communication platform is to enable data exchange and distribution between vehicles and between the roadside and vehicles that is quick and cost-efficient for the vehicle passenger's safety and comfort. The drivers for this technology are user expectations, advances in Information and Communications Technology (ICT), development of new services, safety, and comfort.

In order to fulfill user expectations, it is necessary to design what the user expects and wants. The systems need to provide the user with a sense of always being connected so that information access can occur anytime and anyplace to achieve instant response and ubiquitous connectivity. It is also important that the systems be absolutely secure and cheap.

The advances in ICT have been attributed to the doubling of processing power every 18 months (Moore's Law) and to achievements made in sensor technology and wireless communications, such as the development of WiFi, but the key development has been Ad-Hoc Networking. This new concept in network development will allow us to communicate without the help of towers or any other fixed infrastructures.

Multi-Hop Wireless Networks currently require multiple links to be traversed to reach a destination. Making these Multi-Hop Wireless Networks mobile in the form of Vehicular Ad-Hoc Networks will add another dimension to networking. This opens up the path to the availability of new applications and services. Cooperative driver-assistance applications can be used to make roads safer by exchanging road condition data such as instances of emergency braking and accidents. Decentralized floating car data applications can be used to query other vehicles about traffic flow and weather with the aid of a digital map and GPS technology. User communication and information services can provide online access, chat with passengers in other

cars, transmission of data from commercial vehicles about their products, and roadside e-marketing.

In Europe, prototype vehicles employing Vehicular Ad-Hoc Networks are being tested. These FleetNet cars are capable of communicating in four ways: car-to-car direct, car-to-car via relaying by intermediate cars, car to stationary FleetNet gateway, and car to Internet via stationary FleetNet gateway. There is still a great deal of research needed and a major research and development effort to push forth the Vehicular Ad-Hoc Network to lead to advances in inter-vehicle communications and Internet on the Road.

Best Practices in Building ITS Network Infrastructure

Damian McShane, Technology Services Department, Port Authority of NY & NJ

The Port Authority of New York and New Jersey is developing and participating in several key ITS initiatives, including Northeast Corridor-wide efforts, such as EZ Pass; Metrocard and additional smart card technologies; and regional sharing of traffic data. These initiatives help the Port Authority fulfill its goal of acting as an economic development engine in the New York metropolitan area by spurring economic growth through improving access to the region.

The issues that these projects need to overcome are access to a limited amount of capital dollars, unique physical networks, geographically diverse locations, and IT network security concerns such as connecting to outside agencies and “locking down” ITS networks.

Cost savings solutions that the Port Authority can employ are:

1. Developing ITS networks in conjunction with other initiatives, which include converging applications onto a single network
2. Exploring alternate transport methods, such as wireless solutions to eliminate private line costs
3. Leveraging enterprise infrastructure to transmit data and consolidate information, helping to eliminate costly private lines and raise network security issues.

The Authority will continue to expand its existing ITS networks and applications, which are critical to furthering economic initiatives within the New York area, specifically in Lower Manhattan. It understands that the features and requirements will change according to the available technology. Efforts will be made to deploy networks that will accept legacy interfaces and serial data, but that are also compatible with new technologies both from an interface perspective and a bandwidth perspective. The agency is already sharing information with outside agencies within the region and somewhere down the line, will reach beyond the immediate area. We need to ensure that we are all moving forward in the same direction, from a technology perspective, so that the transition will be a seamless one. The Port Authority of New York and New Jersey is willing to embrace and explore new technologies to meet future requirements.

Panel 2: Local Conditions

Moderator - Isaac Takyi, Director ITS, New Technology Implementation, MTA NYC Transit

While there may be some existing best practices for deploying ITS transit technologies, implementation of each set of ITS technologies in a region requires adaptation to local flavors. Why a focus on local conditions and determining what is happening within the regional area? Local conditions are critical in the ITS department. The challenge presented by local conditions contributes to making the actual on-time deployment of ITS projects very difficult. In this session, panelists discussed local conditions covering both local requirements and local markets for ITS transit technology deployment.

ITS in Northern New Jersey

Michael F. Pilsbury, P.E., Manager, Traffic Operations North, NJDOT

The New Jersey Department of Transportation's (NJDOT) Traffic Operations North division runs four programs: Traffic Operations Center (TOC), ITS Maintenance and Planning Unit, Incident Management Unit, and Emergency Service Patrol. The TOC is located in Elmwood Park, NJ, and is in operation five days a week (expanded to seven days during the summer), 16 hours a day. It has jurisdiction of over 1,000 linear miles of highway, 48 VMS, 86 cameras, 7 HAR stations, 134 linear miles of fiber optic cable, 123 traffic signals, and over 750 detectors.

The NJDOT ITS master plan includes:

1. Connecting the fiber optic cables between the north TOC and south TOC, three regional headquarters, New Jersey Turnpike, and Garden State Parkway
2. Providing live video to the New Jersey State Police (NJSP) and Bergen County Police Departments
3. Actively sending email and pages to TRANSCOM, TMAs, media, private transportation carriers, and NJDOT
4. Provide real-time traffic information through the NJcommuter.com website including camera images and user-defined information filters
5. Planning a 511 system, similar to the 411 system, but for traffic information with the anticipation that the system will be voice activated

The ITS Maintenance and Planning Unit consists of eight staff members. The communication technicians take their vans home and rotate to be on call for emergencies. They also perform their own fiber line splicing. There are two splice trailers, one for Traffic Operations North and the other for Traffic Operations South. Since the fiber lines are hit a lot with down-time, a potential area of research is determining the hourly fiscal loss due to fiber down-time. NJDOT is trying to make sure contractors pay attention to the fiber lines and to ensure that they fix them in the event they are taken down.

The Incident Management Unit is made up of a three person staff with other Traffic Operations North staff participating as team members. The goal of the unit is to work with police, fire firefighters, and EMT workers to clear incidents right away. A partnership has been established with the NJSP in which the Incident Management Unit trains recruits at NJSP and other police academies, and provides outreach to local emergency responders. The Incident Command

System is used and promoted to other agencies to ensure that incidents are cleared in an orderly and efficient manner. Other potential areas for further research include the improvement of Hazardous Materials clearance, and speeding up accident verification.

The Emergency Service Patrol travels continuously cover 173 miles of Interstate highway looking to assist people in need. The patrol is run by two crew supervisors, six assistant crew supervisors, and 32 truck drivers. The patrol recently celebrated its 10-year anniversary and has proved to be a really favorable program. It is federally funded and hopes to have its own fleet of tow trucks. A useful area of research would be to perform a cost-benefit study on the lost time due to accidents during rush hour traffic.

ITS Technology at PATH

Frederick R. Childs, Superintendent, Power, Signals, and Communications, PANYNJ

Port Authority Trans-Hudson (PATH) is a transit service provider operating 24 hours a day, 7 days a week, all year round. It operates 13 stations (7 in New Jersey and 6 in Manhattan) and 1000 weekday passenger trains. During the morning and evening peak periods of service, trains arrive at each station between 5 to 6 minutes. The pre-9/11 average weekday ridership was above 267,000; with current ridership ranging around 185,000 to 190,000, of which approximately 37,000 riders embark at the World Trade Center station.

PATH places an emphasis on customer service. The PATHVision passenger information display system has been implemented as an integrated backbone system with 270 monitors available in 13 stations. These monitor displays are linked to a train tracking system to receive an indication of train arrivals, and are also used to display variable messages to display delays and incidents such as an escalator malfunction. The monitors also serve to display public service announcements, education on connecting systems, basic guidelines such as bicycle usage, news and weather supplied by an outside agency, and revenue enhancement in the form of commercial advertising space. Static travel information boards are also visible at PATH stations. There is also heavy use of station public address systems and onboard train announcements. Passenger information phones are conveniently located at on the platform of every station.

PATH provides interfaces to the outside world that share information network-wide to other agencies. Customers can make use of kiosks available at the stations for public access to the Internet, email, news and weather, and PATHVision. The recently installed workstations also connect to TRANSCOM, providing information on real-time traffic conditions. Within the stations, the first-line communications providers are passenger information agents, Port Authority Police Department, train crews, and employees in the station and in trains. In addition, passenger assistance phones connect directly to the communications center, which has video access to each station.

The Port Authority of New York and New Jersey's transit services are not solely limited to those encompassing the PATH system. Other Port Authority facilities include: JFK, LaGuardia, and Newark Airports; Lincoln and Holland Tunnels; George Washington Bridge; Port Authority Bus Terminal, NYC; Goethals and Outerbridge Crossings, Staten Island, NY; AirTrains at Newark and JFK Airports; and Marine Terminal Ports.

Mapping the Underground City

Dan McHugh, New York City Transit

When people picture a map of New York City, they almost invariably think about a map of the above ground New York City. The underground New York City remains poorly understood in the popular mind, and maps of it are not much better. Yet developing accurate maps of the city's underground is critical for planning and operating the city's infrastructure.

New York City Transit's (NYCT) mapping initiative evolved out of a series of projects, eventually ending up as an enterprise project. It was initially intended to assist in the management of the agency's 5-year capital program. The objective of the program was to update the approximately \$300 billion spent by the agency over the last century. NYCT created databases used for special projects, such as the LaGuardia Airport Access Transit Project Geographic Information Systems (GIS) Map Pilot. These projects have since been consolidated into a single Integrated GIS Map Project, which is supporting both the Lower Manhattan and World Trade Center recovery efforts; and more recently the security initiatives for the upcoming 2004 Republican National Convention at Madison Square Garden. These security initiatives are driving 3D digitalization even further. The NYCT can now share information with other agencies such as the police and fire departments.

NYCT also received an enormous boost for the Integrated GIS Map Project, receiving over \$10 million in investment from multiple agencies for the NYC GIS Project (NYCMAP). Aerial photographs are improving the surface features of maps, helping to identify how underground structures fit into the overall city context. We are now able to have one single linear reference address range to line the 50 to 100 tables that are directly associated with NYCT's 20-year need assessment inventory of assets. In the past it was difficult to place all of the assets into one framework, but NYCT was able to accomplish this through the use of linear referencing and asset hierarchy. In addition, the money spent on the LaGuardia Airport project enabled NYCT to map additional layers for the entire city. In turn, the city project helped move the LaGuardia Airport project further along in its digitalization, so the cooperation has become a symbiotic relationship.

NYCT is now working on a one-foot accuracy engineering-quality multi-layer map that will take each underground rail track (linear reference address ranging), and integrate them with CAD drawings of stations and other facilities. These CAD drawings can be broken down into their asset hierarchies. A station has certain nested features under it, including elevators, escalators, and lighting systems. Integration of these data makes it easier to perform capital work on tracks and neighborhoods in an efficient and coordinated way.

The use of aerial photographs to derive city references, which include surface features like station entrances, enables underground features to be triangulated. The advantage of reliance on GIS over CAD is that it is a database for every graphic element – point, line, polygon – placing it way ahead of CAD in its ability to be manipulated. These new maps will capture individual track features and provide a multi-tiered view while being more user-friendly.

Panel 3: Integration of ITS Technology

Moderator – Brian Cronin, Federal Transit Administration

As ITS systems provide “real-time” sharing of information between ITS-based systems and the coordination of management activities between transportation agencies and multiple service providers, successful integration of ITS technologies is the key to success. Panelists in this session discussed various issues involved in the integration of ITS transit technologies.

As a word on the current undertakings of the FTA, within the last year the USDOT has refocused its ITS research program on the high impact areas of safety, mobility, and productivity with the application of significant resources over the next five years. Nine new programs areas have been developed, key to which are integrated multi-modal services. Two areas that will significantly impact transit are mobility services for all Americans – mobility management for health and human services transportation, similar to what has took place in Gothenburg, Sweden (as outlined in Robert Stanley’s presentation); and integrated corridor operations – a joint program with the FTA’s highway program in examining how to integrate services and maximize capacity in this corridor.

ITS Standards for the Transit Industry

Jerome M. Lutin, New Jersey Transit

Transit operators frequently are locked into proprietary technologies that do not share information well. The industry needs standards to cost-effectively improve the flow of information to customers and managers. This presentation discusses recent efforts within the transit industry to develop standards for the exchange of information in response to changing technologies and federal regulations.

One of the biggest problems for the transit industry was that, until recently, most available intelligent transportation systems used software codes and data structures that were all proprietary to the respective vendors. If a transit system wanted two different systems to talk to one another, the agency often had to go back to the original vendors to modify the codes for their systems. Even after paying the vendors to modify their systems, they might still not be able to communicate with one another, and a counterproductive situation could develop in which both vendors are pointing fingers at each other.

Solving the problem of data integration has prompted the transit industry to develop the Transit Communications Interface Profiles (TCIP), a set of standards that was conceived by Eva Lerner-Lam of the Palisades Consulting Group. TCIP standards are being developed to provide uniform definitions, concepts of operations, message formats and dialogs, that will permit interoperability among systems including fare collection, scheduling, computer aided dispatch, automatic vehicle location, and others needed by the transit industry. The TCIP program is being funded by the Federal Transit Administration and involves hundreds of volunteers from transit agencies and vendors, who are participating in technical working groups and working to achieve industry consensus on the standards.

Multi-Agency ITS Integration – Why is it Good and How do we Get There?

Jim Davis, Acting Downstate Section Head of Transit Services, NYSDOT

Why integrate? There are many benefits resulting from being able to modify information to meet the changes between one transit agency and another in an operations and planning context. Thus, we look for transit ITS technology to realize the potential benefits available in multi-agency coordination. This was the idea behind Trips123, an attempt made to pull information from the 50-plus transit carriers from across the New York, New Jersey, and Connecticut tri-state region into a one-stop shopping internet-based itinerary planning system.

The National ITS Architecture provides a great vision for what regional integration could achieve. The National ITS Architecture will be built around the reasonable assumption that customers desire integrated information and efficient reliable service. Prior to the completion of ITS interoperability standards, this vision for integration is being partially realized through vendor-provided integration, relying on custom data interfaces. Many standards currently exist – TCIP, SAE ATIS, NTCIP DMS, IEEE 1512, etc. – that have the potential to provide a language and syntax for grammar for ITS integration. These standards will permit multiple agencies to integrate their ITS information without requiring costly custom data interfaces. Multi-agency common Geographic Information Systems (GIS) base-mapping is a good example of regional/state integration that doesn't depend on national standards, a statewide example in New York is the Accident Location Investigation System (ALIS), where multiple public agencies are pooling funds to build high quality base mapping that all State agencies can rely upon as a single non-proprietary source of spatial data. This is a collaboration model that may apply to other areas of ITS and software development. There is a need for common applications that can cut across state boundaries without a heavy reliance on vendors.

Will this integration happen? It probably will, but it will require effort, support, and commitment to enhance the tools that make it possible. For compliance to be more than a mandate, operators must be able to see clearly how the National ITS Architecture and standards address their integration needs. There probably also need to be explicit financial incentives for multiple transit agencies to begin collaboration on ITS initiatives.

A major issue hindering this collaboration is the limitation of agency capacity. There are shortages of technical staff. ITS training is available, but not always ranking high in agency priorities. Above all, this collaboration is difficult work. The reality is that all is not bleak. Here are some key thoughts in how we may be able to increase agency involvement in fully developing a regional ITS architecture:

- Develop better approaches to ITS training without intensive time and travel requirements
- Develop tools and templates that can be understood by procurement officers as well as technicians, planners, and accountants
- More efficient means of getting industry participation in standards development
- Share the burden of developing applications that are common to all such as open source software, best practices, possibly aided by financial incentives

Achieving the vision of the National ITS Architecture will prove to be a difficult task, but the end result will be a more efficient and reliable transportation system.

Integration and the Workforce

Arthur Goldberg, Director of the TWU Local 100 – NYCTA Training and Upgrading Fund

The *Transport Workers Union Local 100 – NYC Transit Authority Training and Upgrading Fund* (TUF) was established in January 2003 to train the incumbent workforce in the skills needed to focus on the new technology. The NYC Transit Authority has spent billions of dollars on new technology equipment to make the system potentially safer and more efficient for a growing ridership. Many of these changes employ the use of Intelligent Transportation Systems (ITS). Examples can be seen in rail control and communication systems, which are being centralized with the aid of computer and electronic technology. Maintainers have to deal with electronic fare payment systems in the subway and on the bus. TUF seeks to aid NYC Transit workers, as well as NYC Transit, meet the challenges of these rapid changes, which can bring the company and the union together to work on a common cause.

TUF created basic computer courses of which, almost 3,000 Local 100 members have completed thus far. About 300 have taken the basic electronics course. In April 2003, a 75-hour course entitled *Telecommunications Technology in Transportation (T³)* was launched in conjunction with New York City College of Technology. Employees explore how new technologies are being applied throughout NYCTA operations with classroom presentations, hands-on work, demonstrations and field trips to new TA facilities.

The science and technologies are here. The training institutions are being built. However, the science tends to precede the social organizations that must adjust in the wake of the technological advancements such is the case at NYCTA. The integration of ITS will not only require changes to be made in workforce development and deployment but also the reorganization of departments, management, and perhaps most importantly, financial policy. NYC Transit faces a financial challenge in addition to the technological one. Service cutbacks may result from the cutting of the operations budget by 10% (\$355 million) to finance capital programs. Furthermore, the *December 2003 Review of the Financial Plan for the MTA*, by State Comptroller Hevesi has revealed “that debt servicing is expected to double from \$792 million in 2003 to \$1.7 billion in 2007 because of a heavy reliance on debt to finance the 2000-2004 five year capital program. This has a real potential of undermining the whole purpose of the twenty year investment in new technology, which is suppose to improve service not reduce it. On top of training workers to fully utilize the benefits of ITS, finding a way to finance its upkeep with a sound financial plan should also be among the myriad discussions surrounding ITS integration.

With \$9.1 million, overseen by union and company trustees, the mission of the Training and Upgrading Fund is to, “give opportunities for [NYC Transit] workers to remain highly skilled, thus providing the best possible service and maximizing the value of the public investment in transportation.” The union is interested in an expanding transportation industry that will provide job opportunities. The company wants safe and efficient transportation as well as the best people to operate and maintain its new technology investments. These goals have created a mutual interest in workforce development and a new kind of collaboration between labor and management. This can only aid in the expansion and long-term interest of mass transit.

Workshops

Workshop 1: Operations and Maintenance

Moderator – George List, Professor and Chair, Civil and Environmental Engineering, RPI

Successful ITS projects do not just stop at the end of their deployment. They involve a long-term commitment in operations and maintenance. A lively discussion on rail (subway) related issues and buses focused on operations management, equipment maintenance, patron support, and service integration, all from an ITS perspective. Woven into the discussion were some questions about the ways in which ITS technology is currently being deployed and might be deployed in the future in both the rail and bus systems.

Rail (Subway) System

Operations Control: Automatic vehicle location (AVL) is being introduced so that train location can be tracked throughout the network. The discussants indicated that this provided an ability to determine the train number, its “exact” location, consist (car numbers), and status, at least to some degree. Whether the AVL information could be used for actual Computer-Based Train Control (train acceleration, deceleration, signal compliance, platform positioning, etc.) is yet to be demonstrated. New York City Transit plans to test CBTC technology in increasingly complex operating environments over the coming decade.

Stations: Video monitoring exists in many subway stations, observable to the conductor for door control at some but not all locations. Other safety issues discussed related to the conductors’ ability to safely see the platform-side monitors, and the possibility that a wireless link to the conductor’s cab and a monitor in the conductor’s cabin might be a useful idea.

Patronage Analysis: Subway patronage analysis is presently done off-line, based on MetroCard data. Although trip destinations are not captured, the cards do have serial numbers, so commuting patterns can be discerned by linking morning and evening entry points. Origin-destination (OD) patterns are deducible even though they are not observable.

Equipment Monitoring: The condition of the rolling stock is monitored at the yards, but not while trains are underway. It is unclear whether AVL systems can provide useful real-time condition information. The sense was that pre-emptive preventive maintenance is possible with the equipment monitoring technology now in place.

Customer Support: Customer support, especially through variable message signs, is increasing. It appears that the AVL data will be used to inform signs on the platform that portray expected train arrival times.

Research Opportunities: Research opportunities exist in two areas. The first is assistance to the NYCT in experimenting with emerging technologies that will further expand the ITS capabilities of the system. The second is assessment of the value added by these investments, in the sense of designing assessment methodologies and conducting the assessments. The ability to integrate assessment rigor and ease of results interpretation is of key importance.

Bus System

Operations Control: An AVL system is to be introduced on NYC Transit's buses. Difficulties in dealing with the "canyon" effects of tall buildings and reflections from glass surfaces have been impediments. One contractor, hired several years ago, was unable to deliver a workable system. Presently, potential contractors are being invited to demonstrate their ability to meet NYCT's needs. A staged, incremental implementation, with an ever-increasing number of buses, is planned. Dispatchers and drivers will be privy to the data collected. Display of the AVL information at sheltered bus stops is planned. These are, however, a fraction of the 15,000 bus stops in the system. Ideas for further capabilities, once the system is introduced include integration with the signal control system(s), coordination of passenger transfers between buses, feedback to drivers about schedule coordination among interrelated services. Another thought is service redeployment in response to incidents.

Patronage Analysis: Ridership is monitored by checkers who ride the buses. There was no discussion about whether OD patterns are monitored using the MetroCards. It is reasonable to assume that that is done as with the rail (subway) system.

Equipment Monitoring: MIDAS, maintenance information system, has been implemented. The newer buses are equipped with monitoring equipment that allows downloading use histories at the depot. The AVL system may have monitoring capabilities as well, with querying possible upon return to the depot.

Customer Support: The bus system customers are a seasoned clientele. They only want to know about delays, etc. by route. Route guidance is not desired. They feel they know their routing options better than any decision support system can assist.

Research Opportunities: Research opportunities exist in several areas:

- Assistance in experimenting with emerging technologies.
- Assessment of investments, in the sense of designing assessment methodologies and conducting the assessments. It is important to ensure that assessments are rigorous, they can be carried out in a range of different network and traffic conditions, and that results can be easily interpreted.
- Research and development effort to push forward the Vehicular Ad-Hoc Network to lead to advances in inter-vehicle communications and Internet on the Road.
- Information management, including data integration, data presentation (e.g., on websites), transmission of data to personal data assistants, etc.
- Assessment of the best mechanisms for customer support, as with the use of synthesized voice to cell phones.
- Investigations of ways to get information about system status into the hands of the ticket booth operators so they can provide accurate and up-to-date information to inquiring riders.
- Experimentation with computer-aided dispatch.
- Automatic bus driver access to more information than is made publicly available from highway congestion management systems, including detection of accidents, deployment of rapid response crews, etc.

- Institutional designs for effective workforce development and deployment, as well as the reorganization of management responsibilities, to promote flexible, ITS-empowered operations.

Final Thoughts

Final thoughts included the challenge of investment decision making, determining what technologies to introduce, when, where, and how. The key is to follow a value added investment strategy. The technology exists. The major challenges are getting information to decision-makers, and implementation.

Workshop 2: Safety and Security

Moderators – Catherine T. Lawson, Assistant Professor of Geography and Planning, University at Albany and Cynthia Chen, Assistant Professor of Civil Engineering, CCNY.

In addition to its potential for relieving traffic congestion, ITS technologies also promise to improve safety and security. Although safety and security are often mentioned together, they represent different bodies of knowledge, from a training and education standpoint. Experts in safety are not experts in security, and vice versa. It is important to explore potential areas for the deployment of ITS technologies for the purpose of improving both safety and security.

Especially after the events of September 11, 2001, security is now at the forefront of transit agencies. Since then, a lot of money has been spent very quickly and it has been discovered that the systems put into place for security in transit are not integrated. Questions lie in where the money went, how was it used, and what do we do next?

The following are areas of potential research activities that the panel came up with:

- Quantification of the tradeoffs between costs and benefits (increased cost in security versus impact on the economy, increases in travel times, and reduced rate of unexpected events etc.)
- Identification of a balanced objective for public transit that often face conflicting objectives (safety, security, efficiency and etc.)
- Impacts of increased security on travel behavior and ridership
- Public outreach and education program
- Integration of new security protocols into existing ITS technologies
- Setting up best practices models
- Separating safety from security
- Potential application of roving security inspection at critical points
- Maryland case study on the use of metal puffers
- Isolation of post-event evacuation scene
- Tradeoffs between increased security and privacy (e.g., video cameras)
- Development of standards for search activities at critical points (e.g., airports)
- Development of MOUs for information sharing (information collected for security purposes should not be used for other purposes)
- Incorporation of security concept in the design phase
- Network security (e.g. connecting to outside agencies and “locking down” ITS networks)

Workshop 3: Customer Service

***Moderator – John C. Falcocchio, Chair for Department of Transportation Planning,
Polytechnic University***

In determining what kind of support will benefit customers, it is necessary to identify the customers of the respective transportation system and identify their needs. The panelists engaged in a discussion focusing on these issues, as well as describing how ITS technologies can help in meeting customer needs

Customers can be divided into four main categories: users, employers, property owners, and government funded agencies. Within the user category, there are three groups: primary users, less frequent users, and potential users. Each user group can be further classified as “drivers” or “non-drivers.” Based on this taxonomy, it is possible to identify who the customers of a transportation system are comprised of.

The needs of the customer are dependent upon which category they fall into. Users are primarily concerned with ease of use/convenience, comfort, quality of service, and safety/security. Factors that affect their judgment of ease of use/convenience are the fare, fare policy, information (real-time delivery and reliability), reliable service, and ability for transfers. Comfort is determined by climate control, space for luggage, crowding, stop announcements, and ability to use cell phones among others. Quality of service is based on traffic congestion, in-vehicle travel time/speed, and door-to-door travel time/speed. Finally, safety/security factors were covered by the previous workshop panel.

The customer needs of employers are dependent upon fare medium program support, reliable service, service availability, access to labor, and fares. Unfortunately, no time was spent discussing the property owners customer group. Elements crucial to the needs of government funded agencies are cost-efficiency of services, reduced customer complaints, customer satisfaction, effectiveness of services, service equity, and safety/security.

ITS technologies can help meet customer needs through:

- Electronic Fare Payments
- Smart Cards
- Automatic Vehicle Location (AVL) systems
- Real-time information sharing (schedules, delays, service interruptions, etc)
- Deployment of traffic signal systems that can provide priority to buses
- Pre-trip traveler information for itinerary planning
- Tracking requests for service
- Automatic Passenger Counts (APC)

Potential research activities will involve quantifying the benefits provided by ITS technologies in each of the above need areas, and to determining the benefit-cost ratios of ITS investments.

Workshop 4: Finance, Costs & Benefits
Moderator – Jim Cohen, John Jay College

This workshop had representatives of many agencies from the region, including people with experience in finance and ITS. Topics discussed included the implementation of a new bus transit system in Stamford, Connecticut; the multibillion-dollar five-year capital plans of the Metropolitan Transit Agency (MTA) and their current operating deficits; the Port Authority's attempts to deal with large amounts of traffic management data; and the MTA's attempts to implement a system-wide human resources and purchasing management system.

The workshop determined potential areas of study that would benefit all the involved groups:

- Potential for the joint use of ITS technologies. This includes the integration of technologies, partnerships, both functional and geographic. *Example: studying the possibility of transit agencies in the tri-state area posting their schedule information on the web in a common format for ease of use for both travelers and other agencies.*
- Costs and benefits. There is a need to quantify the benefits of these projects and show the distinct benefits and costs of alternative ITS technologies and investment options. Related to this, there could also be an effort to assess the benefits of ITS system reliability, such as determining the hourly fiscal loss due to fiber optics system down-time.
- Alternative models. There always has to be thinking outside of the box. *Examples: continuous procurement, compatibility of equipment, integrated procurement (all for lowering cost); exploring public versus private ownership.*
- Strategies for maximizing the long-term benefits of proprietary systems. These include eliminating, moving beyond, or taking advantage of proprietary systems in the public sector and capturing rights to the use of technologies for the long-term benefits of the customer and the agency. *Example: fare collection in Boston.*

Speaker Biographies

Robert E. Paaswell, Ph.D., P.E., is Distinguished Professor of Civil Engineering at The City College of New York, Director of the University Transportation Research Center, and Director of the CUNY Institute of Urban Systems. He has been involved in transportation operations, management and planning since the late 1960s. From 1967-1968, he helped write the Model Cities Transportation Program for Buffalo, N.Y. While a Professor of Civil Engineering at State University of New York at Buffalo (1964-1982), Dr. Paaswell organized and directed the Center for Transportation Studies and Research. From 1980-1982, Dr. Paaswell was Chairman of the Urban Planning Department at SUNY Buffalo. From 1986-1989, Dr. Paaswell served as Executive Director (CEO) of the Chicago Transit Authority, the second largest system in the U.S.

Frederick R. Childs is Superintendent of PATH's Power, Signals and Communications Division in Jersey City, New Jersey. Fred joined the Port Authority of N. Y. & N. J. in 1996, and was appointed Superintendent of the PS&C Division in June 2001. Fred is responsible for a diverse organization that operates and maintains a wide variety of electrical, electronic, traction power, signal and train control and communications systems. Before joining PATH, Fred was a project engineer at SEPTA in Philadelphia. He started his career with Conrail and later worked several years for consulting engineering firms, including project management and design support for a number of commuter rail, light rail and rapid transit systems on both the East and West coasts. Fred has a B.S. degree in Construction Management from Drexel University and a B.A. degree from Temple University.

Brian Cronin is the Acting Chief for the Advanced Public Transportation Systems Division in the Federal Transit Administration's Office of Research, Demonstration and Innovation. Brian manages the technology research program related to intelligent transportation systems. Brian has 10 years of experience in technology for transportation and has a Masters of Science in Civil Engineering from Texas A&M, and a Bachelors of Science in Civil Engineering from Virginia Tech.

Jim Davis is currently the Acting Downstate Section Head of the Transit Services Bureau for the New York State Department of Transit (NYSDOT). In this position he oversees NYSDOT operating and capital assistance programs in the 12-County Downstate Region. He is the Department's lead on the transit elements of the TRIPS 123 ITS Model Deployment Initiative and the Transit Program Liaison to Department Initiatives in ITS incident management and standards deployment. He is currently serving on the TCIP standard development Technical Working Groups for Passenger Information and Spatial Representation. Previously, with Palisades Consulting, he was the project manager for the TCIP development effort. Prior to working at NYSDOT he worked with the Bergen County Planning Department on transportation modeling and land use planning. Mr. Davis received both his Bachelors and Masters degrees from SUNY at Albany in Public Policy and Regional Planning respectively.

John C. Falcocchio is Professor of Transportation Planning and Engineering and Director of the Urban Intelligent Transportation Systems Center (UITSC) at Polytechnic University in New York. Dr. Falcocchio specializes in the planning and management of urban transportation

systems. His interests include the study of the relationship between land use and travel; how to use the transportation planning process in decision making; the use of real time information (ITS) in managing transportation and travel demand; and monitoring and evaluating transportation systems through the use of criteria and performance measures that reflect the perspectives/needs of diverse stakeholders. He has managed complex transportation projects both as an educator/researcher and as a practicing professional. He is a founding principal of Urbitran, a major planning and engineering consulting firm, and is a registered professional engineer in Pennsylvania, New York, and California. Dr. Falcocchio is an author and co-author of many professional papers and one book. He has a Bachelor in Civil Engineering and a Ph.D. (Transportation Planning) from the Polytechnic Institute of Brooklyn, and is a graduate in Traffic Engineering from the Bureau of Highway Traffic, Yale University.

Arthur Goldberg is the Director of the Transport Workers Union Local 100 – New York City Transit Authority Training and Upgrading Fund, which delivers customized training opportunities to incumbent transit workers. He joined the New York City Transit Authority as a Plumber in 1977. In 1980, he was elected as a Local 100 union representative in the Structural Division representing 1700 construction workers. After studying the new technology in transit and NYCTA budgets he started the Awareness Campaign about technological changes in the industry. In 2001 he was appointed by TWU Local 100 President Roger Toussaint as the Director of the newly created Training and Upgrading Fund, which is jointly trusted by company and union trustees.

Thomas J. Kimpel, Ph.D., is a Research Associate at the Center for Urban Studies in the School of Urban Studies and Planning at Portland State University. He received his Doctorate in Urban Studies from Portland State University and his Master's in Urban Planning from the University of Virginia, Charlottesville. He was named Outstanding Student of the Year for U.S. Department of Transportation, Region 10 in 2001 and was awarded the American Institute of Certified Planners Outstanding Student Award at the University of Virginia in 1995. Dr. Kimpel has participated in a number of bus transit-related research projects involving the Tri-County Metropolitan Transportation District of Oregon. His research interests include geographic information systems, transportation, and econometric modeling.

Eva Lerner-Lam has 27 years of experience in transportation planning, operations, research, and policy making. Founder and President of the Palisades Consulting Group, Inc., she leads many national technical committees focused on transportation security policy. She has served in several key public sector positions, including Director of Planning and Operations for the San Diego Metropolitan Transit Development Board and Member of the New Jersey Transit Corporation Board of Directors, and has received numerous professional awards and honors. She is a graduate and past Trustee of Princeton University, and earned a Masters degree in Civil Engineering/Transportation Systems Division from the Massachusetts Institute of Technology.

Jerome M. Lutin, Ph.D., is Senior Director of Intermodal Planning for NJ TRANSIT, New Jersey's statewide transit operator. Dr. Lutin also serves as Co-Chair of the American Public Transportation Association (APTA) Task Force on Transit Communications Interface Profiles (TCIP). He holds a Master of Architecture and Urban Planning and a Ph.D. in Urban Planning from Princeton University. A licensed professional engineer and urban planner, Dr. Lutin has

over 30 years of experience in transportation including service as an officer in the U.S. Air Force and ten years of teaching and research on the faculty of Princeton University. In addition, he served as Vice President and Technical Director for a major engineering firm.

Dan McHugh works for the MTA New York City Transit and is an authority on their Geographic Information Systems (GIS) projects.

Damian McShane is a Senior Project Manager with the Port Authority in the Technology Services Division. Having spent 13 years in various roles designing and building telecommunications networks in private industry, his current focus is on developing and implementing converged systems within the Port Authority for transport of various applications over a shared infrastructure. Mr. McShane's present focus is on PATH network and in establishing a PA wide ITS network to collect and share pertinent information between facilities utilizing the PA enterprise network.

Kaan M.A. Ozbay, Ph.D., received a B.S. in Civil Engineering in 1988 from Bogazici University, in Istanbul, Turkey, an M.S. in 1991 in Civil Engineering (Transportation) from Virginia Tech and a Ph.D. in Civil Engineering (Transportation) in 1996. Dr. Ozbay joined Rutgers University Department of Civil and Environmental Engineering as an assistant professor in July, 1996. He was promoted to Associate Professor with tenure in July 2002. Since 1998, he is also the Associate Director of the newly established Rutgers "Center for Advanced Infrastructure and Transportation (CAIT)" sponsored by the Federal Highway Administration's University Transportation Centers (UTC) program. Dr. Ozbay is the recipient of the prestigious National Science Foundation (NSF) CAREER award. Dr. Ozbay has co-authored three books and published more than 60 papers in scholarly journals and refereed conference proceedings.

Michael F. Pilsbury, P.E., graduated with a B.S. in Electrical Engineering from Rutgers University in May of 1986 and began working for the NJDOT as an Engineer Trainee in the Newark Headquarters. In 1989 he was admitted to the Graduate Program at NJIT and went to school at night and in 1993 graduated with high honors with a M.S. in Engineering Management. In 1992 he designed and supervised construction of the NJDOT's first integrated Intelligent Traffic System (ITS) - Route 4 & 17, CCTV and HAR. In 1994 he became second in command on the ITS project entitled MAGIC. During the course of his stay with Electrical Engineering he progressed through the titles of Assistant Engineer, Senior Engineer and to Principal Engineer. In 1996 he was selected as the Executive Assistant to the Executive Director for the North Region. In 1996 he also became licensed as a Professional Engineer in the State of New Jersey. In 1999 he completed all six levels of CPM training and became a Certified Public Manager. In September of 2001 he was selected as the Manager of Traffic Operations North, and in this position he currently supervises a staff of 65.

Tarek N. Saadawi, Ph.D., is Professor of Electrical Engineering at City College of New York, where he currently also directs the Center for Information Networking and Telecommunications. His current research interests are telecommunications networks, high-speed networks, multimedia networks, ad-hoc networks and packet radio networks. He has published extensively in the area of telecommunications networks. He is a co-author of the book, *Fundamentals of Telecommunication Networks*, John Wiley & Sons, 1994. He is the general co-chair of the IEEE

Symposium on Computers and Communications. Dr. Saadawi is a former chairman of the IEEE Computer Society of New York City (1986-87). He has received the Region 1 Award, 1987, and the Nippon Telegraph and Telephone of America Award for research on Broadband Telecommunications Networks.

Robert G. Stanley is a Principal of Cambridge Systematics with 30 years of experience in transportation and urban planning at the local, regional, state, and Federal levels. Mr. Stanley is serving as a principal resource to the American Public Transportation Association (APTA) and American Association of State Highway and Transportation Officials (AASHTO) in the development of policies, positions, and advocacy strategies to guide reauthorization of the Transportation Equity Act for the 21st Century (TEA-21). He has directed major research efforts through the Transit Cooperative Research Program (TCRP) and National Cooperative Highway Research Program (NCHRP). He serves in an on-call capacity to APTA in the development of positions and proposals for consideration in the Federal Highway Administration (FHWA) National Dialogue on operations and industry outreach. Prior to joining Cambridge Systematics, Mr. Stanley served as the Executive Director for Policy and Programs at APTA. Over a 10-year career, he directed major policy, planning, research, and intergovernmental relations programs. Prior to working at APTA, he was on the policy and planning staff of the Federal Transit Administration (FTA), served on the Congressional staff, and spent five years consulting on transportation, transit, and urban development projects. Mr. Stanley received a Master's degree in City Planning from the University of North Carolina at Chapel Hill, and a Bachelor's degree from Colgate University.

Isaac Takyi, Ph.D., has been with New York City Transit for a little over 10 years where he has been responsible for a variety of key assignments including operations planning of facilities and equipment, piloting of intelligent transportation systems (ITS), deployment of ITS architecture and standards and most recently, customer relations management of technology and information services in the agency. He co-chairs the Transit ITS Standards Committee for TCIP and is a member of the Board of Directors of ITS New York. He has published several articles on ITS and transit service management and performance, and taught transportation courses at various universities including the University of Pennsylvania, CCNY, and NJIT. Isaac holds a PhD degree in Transportation from the University of Pennsylvania.