Advanced Traveler Information System (ATIS) Implementation and Integration

Electronic Toll and Traffic Management (ETTM) Evaluation Report

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<th>Description</th>
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<tr>
<td>ATIS</td>
<td>Advanced Traveler Information System</td>
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<tr>
<td>AVI</td>
<td>Automatic Vehicle Identification</td>
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<tr>
<td>CCTV</td>
<td>Closed Circuit Television Camera</td>
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<tr>
<td>CUBRC / GD</td>
<td>CALSPAN University of Buffalo Research Center/General Dynamics</td>
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<td>DSRC</td>
<td>Dedicated Short Range Communications</td>
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<td>ETTM</td>
<td>Electronic Toll and Traffic Management</td>
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<td>FHWA</td>
<td>Federal Highway Administration</td>
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<td>ITS</td>
<td>Intelligent Transportation Systems</td>
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<tr>
<td>mGate™</td>
<td>A new Tag Reader Developed by MARK IV</td>
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<tr>
<td>NCSU</td>
<td>North Carolina State University</td>
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<td>NYSP</td>
<td>New York State Police</td>
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<td>NYSDOT</td>
<td>New York State Department of Transportation</td>
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<td>NYSTA</td>
<td>New York State Throughway Authority</td>
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<tr>
<td>NYU-POLY</td>
<td>Polytechnic Institute of New York University</td>
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<tr>
<td>PPC</td>
<td>Pocket Personal Computer</td>
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<td>RFP</td>
<td>Request for Proposal</td>
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<td>RFID</td>
<td>Radio Frequency Identification</td>
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<td>RPI</td>
<td>Rensselaer Polytechnic Institute</td>
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<td>TIRC</td>
<td>Transportation Infrastructure Research Consortium</td>
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<td>TIM</td>
<td>Traffic Incident Management</td>
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<td>TMC</td>
<td>Traffic Management Center</td>
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<td>TRANSCOM</td>
<td>Transportation Operations Coordination Committee</td>
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<tr>
<td>TRANSMIT</td>
<td>TRANSCOM’s System for Managing Incidents and Traffic</td>
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<tr>
<td>UITSC</td>
<td>Urban ITS Center at Polytechnic University</td>
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<tr>
<td>E-ZPass®</td>
<td>A trademark name for the Toll Collection System in the Northeast</td>
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Executive Summary

Background
This evaluation report presents key findings from the Electronic Toll and Traffic Management (ETTM) phase of Advanced Traveler Information System (ATIS) Implementation and Integration project by the Transportation Infrastructure Research Consortium (TIRC) under the auspices of the New York State Department of Transportation (NYSDOT).

The ETTM phase was lead by Rensselaer Polytechnic Institute (RPI), with the collaboration of Cornell University, Polytechnic Institute of New York University, North Carolina State University, Annese & Associates and Mark IV Industries.

This project consists of (1) the development and (2) field testing of the prototype wireless-based solar powered E-ZPass® tag readers by Mark IV Industries.

Project Objective

The main objective of the ETTM project was to develop and field test six mGate E-ZPass® tag readers, powered by solar panels, to collect and demonstrate the accuracy of the link travel time and speed data using wireless communication interface.

The ETTM project has produced a novel and deployable new tag reader technology. Unlike the conventional E-ZPass® tag readers, which use utility power as well as fixed communications and antennae mounts, this new device is powered by solar panels and data is transferred wirelessly from the device to a central server. These devices can be mounted on a moveable trailer or roadside pole.

This new tag reader system can be used in a variety of traffic management applications, including arterials, special events, incidents and work zones. This new concept of transportability and “green energy” makes the device attractive for field deployments under all weather and where power and communication is not practical or available.

The ETTM project has developed a practical methodology that public agencies can deploy efficiently in collecting real-time data for traffic management. This new reader provides for an affordable low-cost solution that can be implemented where sufficient penetration of tags exists at any time to meet operational needs. (A traditional method of erecting readers for TRANSMIT application in the field requires trenching and conduits installation at very high fixed costs).

Key Findings

Table-1 presents a brief summary of the key findings pertaining to the ETTM project on the effectiveness of the various processes encountered. These findings are based on the evaluation methodology, adopted by the local evaluation team (NYU-POLY), which included reviews of task reports issued by the team, interviews with project partners and sponsors, and attendance at the meetings and workshops held by the team.
<table>
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<th>#</th>
<th>Category</th>
<th>Key Findings/ Lessons Learned</th>
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| 1 | RFP Process              | • The RFP did not specify a particular product or deployment installation method. This decision actually helped NYSDOT and other partners to deal with unforeseen field deployment issues.  
**Lesson Learned:** A specific-technical approach to develop a new project should not be an RFP requirement without proof that such an approach can work for the case in question. |
| 2 | Contracting Process      | • This project suffered significant contracting delays. Some of which could have been avoided by better communication and administrative controls. The project schedule was severely impacted either due to field issues or to receive approvals from public agencies for installation.  
**Lesson Learned:** A research project should be undertaken as a demonstration project and should be exempted from general contracting procedures such as those required by this RFP. |
| 3 | Partnering Process       | • Partnering with MARK IV, in the development of the mGate-based prototype tag reader system, was a very effective process as the vendor is a highly successful manufacturer of conventional readers and quickly grasped the needs of this project. The RPI team was capable to work with an unproven emerging technology and to manage a range of field hurdles and issues, while NYSDOT undertook the approval process. |
| 5 | Project Management       | • The project team exercised flexibility during the technical set up process, project development, and field installation and testing efforts. Team coordination requirements were a significant part of this project and NYSDOT provided the necessary support and guidance on installation practices to keep the project moving.  
• The project team focused on the resolution of the technical issues by remaining flexible during the field testing activities. |
| 6 | ETTM Practices           | • This research project has advanced the current knowledgebase on ETTM applications for traffic monitoring in NYS by providing an implementable product. |
| 7 | Project Expectations     | • This demonstration has brought public, private and research partners together, and has shown how a promising idea can result in an implementable product.  
• The project partners and sponsors have expressed satisfaction with the new reader’s capability to serve multiple applications in the traffic management area. |
| 8 | Conclusion               | • This project has developed a new tag reader, powered by a solar panel, not thought of before, and using a wireless method to transfer data with full integrity. This innovation can create a transportable reader system that can be moved from location to location quickly and at low installation cost.  
• This ETTM project has contributed to the advancement of “green energy” applications in transportation. |
Summary of Project Benefits

The following summarizes the benefits resulting from the ETTM research project:

- **Benefits to NYS:**
  
  o **“Thinking Outside of the Box”:** the successful development of the wireless solar powered tag reader has demonstrated that “thinking outside of the box” can bring innovative ideas to fruition. The results of this research project should encourage NYSDOT to explore other application areas where portability and private-sector partnering may offer cost effective to using fixed infrastructure devices in traffic monitoring.
  
  o **Moving Towards Wireless Infrastructure:** new readers with ad-hoc capability of solar power panels and Bluetooth wireless communications have a reliability equivalent to that achieved with the traditional approach that uses fixed infrastructure location devices powered with electric utility and wired communications. Where power and communications are not readily available, low-cost solar powered mGate readers can be easily deployed to collect travel time data for traffic management applications such as incident detection, special events and work zones.
  
  o **Investing in “Power of Green Energy”:** This project leads to the development of “green energy” in traffic monitoring with the application of solar power for tag readers with the wireless communications method for data transfer.
  
  o **Partnering with Private Sector:** NYSDOT/NYSTA would benefit from future ETTM wireless reader projects in partnership with the private sector through the development of low-cost solutions to traffic monitoring. Building future projects on the partnering approach of this research would make it possible.
  
  o **Making a Business Case:** This project has demonstrated that a business case can be made for enhancing ETTM practice in NYS by augmenting the conventional fixed infrastructure – based program with the portability aspects of readers. TRANSMIT and ETTM applications that deploy fixed readers in the area could benefit from a mix of both types of readers.
  
  o **Broadening Knowledgebase:** This project has contributed to expanding the knowledgebase of electronic hardware and ETTM practices at NYSDOT. For example, wireless methods and data integrity were expressly resolved by bringing knowledge from other industry and experts.
  
  o **Environmental Impacts:** The implementation of transportable ETTM readers and wireless communications in the NYS region can result in minimizing traffic delays, thus contributing to a reduction in pollution and energy usage, and contributing to improvements in mobility as well as in road traffic safety.
• Benefits to the Private Sector:
  Better Understanding of Public Agencies’ Needs

  o This evaluation finds that the private sector has benefited from the better understanding created by this project on exploring newer approaches to product development that potentially meet public agencies’ needs for power where electric power and communications facilities are neither available nor practical. It has also explored the capability to monitor traffic speed without the need for embedding readers in the infrastructure.

  o The private sector partner, Mark IV, benefited from close working relationships with public agencies, and valuable research support provided by the RPI team during development and installations of the readers.

• Benefits to FHWA:

  o Valuable lessons learned from this project include low-cost products than can be designed with users’ input, are deployable, testable and transportable by using emerging technology. This in turn can help FHWA in enhancing their traditional role in sharing knowledge and experiences with other agencies and encourage agencies to “think outside of the box”. This benefit has national implications in the ETTM and ITS application areas.

  o In keeping with the US National Energy Policy, FHWA can encourage transportation agencies to open doors to “green energy” applications in this sector.

  o This project has provided insight into emerging technologies for both ITS applications such as the use of Bluetooth interface for data communication with RS 232 port. This knowledge can be circulated by the FHWA to other regions.

Lesson Learned
“We have gained a lot in terms of understanding agencies’ needs and we are always willing to work with them.”
-Paul Manuel
Project Manager
Mark IV Industries, Inc.

Lesson Learned
“This project has given us some leads to bring green energy based products in transportation applications which in turn could lead us to a affordable product that towns, cities and states can use over a wide area for traffic management and information.”
-Michael Schauer, FHWA
1.0 Introduction

1.1 Project Background

The Electronic Toll and Traffic Management (ETTM) project (hereafter referred as the ETTM Project) is a third phase of the ATIS project that was initiated in 2001 by the Transportation Infrastructure Research Consortium (TIRC) under the auspices of the New York State Department of Transportation (NYSDOT) under proposal # Z-01-02.

Under the guidance of the NYSDOT, the ETTM project was lead by Rensselaer Polytechnic Institute (RPI), and supported by Mark IV Industries and North Carolina State University (NCSU) and begun in early 2006. Based on the emerging tag reading technology, RPI in conjunction with Mark IV Industries was charged to develop the prototype for a wireless, solar powered E-ZPass tag reader. This effort is described in tasks 22-31 (Ref 1).

1.2 Project Objectives

The main objective of the ETTM project was to develop and field test six mGate based E-ZPass® tag readers by collecting and demonstrating the accuracy of the link travel time and speed data using wireless communication interface and using solar panels.

The system thus designed should be transportable from site to site. Such a system should be of high value to a wide range of system operators, ranging from state agencies like NYSDOT to local towns and cities. The new device was to cut the present dependence on power and wired telecommunication access so that the device, once commercialized, can be deployable anywhere, anytime.

1.3 What is the Value of the ETTM Project?

Public agencies operating ETTM infrastructures in and around NYS deploy fixed location based tag readers in areas where fixed sources of power and communications are practical and available. However, where power and communications facilities are not available, real time link travel data for traffic management cannot be obtained. This includes both arterials and freeways.

This project has addressed this need by investigating the feasibility of a tag reader system that is transportable and can be powered with solar panels and uses wireless communication. This
research project has demonstrated, with a prototype and field installations, the reliability and accuracy of the new reader for collecting link travel time and speed data.

1.4 Role of the Polytechnic Institute of New York University

The Urban ITS Center (UITSC) of the Polytechnic Institute of NYU (NYU-POLY) has been retained as sub-contractor by RPI to provide assistance in evaluating issues such as the effectiveness of the partnering relationships, the effectiveness and means used to resolve technical issues, and techniques used with the private sector, including finances.

This local evaluation report presents key findings and lessons learned for the primary benefit to the members of the Transportation Investment Research Consortium (TIRC) and will be a reference for the New York State Department of Transportation (NYSDOT) for future work.

1.5 Purpose of the Evaluation Report

The purpose of this evaluation report, as required by the FHWA, is to present key findings and lessons learned from the project tasks performed during the development of a prototype RFID tag reader system, field testing, and product performance evaluation (Ref.2).

The information presented in this report is based on the task reports developed by the project team (Ref.2), the discussions at the meetings and workshops and interviews with the project team members. The report focuses on the processes used during the project development and contract management, development of technical solutions and partnering relationships, and roles played by the public and private sectors during the project.

This report does not evaluate the vendor performance, product features and functions developed for the experimentation and deployments. These topics have been amply documented in project reports (Ref.2).
2.0 Evaluation Methodology

2.1 Evaluation Definition

According to the ITS Evaluation Guidelines-TEA-21 Evaluation Guidelines, “evaluation is the reasoned consideration of how well the project goals and objectives are being achieved. The primary purpose of the evaluation is to cause changes in the project so that it eventually meets or exceeds its goals and objectives” (Ref. 3).

2.2 Evaluation Methodology

Based on the above stated guidelines and definition, and the project scope requirements, the following evaluation methodology is used:

- The evaluation team gathered and reviewed project information, data analysis, and project task reports, published papers from the project team.
- The evaluation team has attended the project review meetings, workshops and telephone conversations with the project team members.
- The evaluation team conducted interviews with the RPI project managers, the new tag reader vendor Mark IV, and the NYSDOT project manager (Ref.4).
- The evaluation team reviewed the current ETTM practice, and wireless communications interfaces, and validity and applications of travel data in ITS applications.

2.3 Key Evaluation Questions

The following questions were posed by the evaluation team to the concerned parties and discussed in some fashion:

- What were the key issues related to the Request for Proposal (RFP) and contracting processes and what were their impacts on the ETTM project development, implementation and schedule?
- How the project team and partnering relationships were formed, and what have we learned from this experience?
- What were the technical issues or difficulties faced by the project team and how they were overcome? What was the level of cooperation, communication and coordination among public sector agencies, and what institutional issues were encountered and how they were resolved?
- What role did the private sector organizations play in product development and implementation? Did this research project help the private sector in product development
that meets NYSDOT’s needs and makes a business case (commercialization) for new tag readers in the State?

2.4 Summary of Key Issues

The evaluation team has identified the key issues based on the interviews and discussion with NYSDOT and the project team partners, and then reviewed the information presented in the detailed project task reports (Ref.2).

This evaluation report presents key findings in seven categories of interest to NYSDOT and the other partners;

1. **Request for Proposal (RFP) Process** – The key issues related to the RFP and the impacts on the actual project later on.
2. **Contracting Process** - Efficiency of the contracting process; the impacts of contract delays on project development and schedule.
3. **Project Team Development Process** - Conclusions about the building of the project team; the challenges in selecting appropriate partners and developing working relationships.
4. **Institutional Coordination Process** - Cooperation between the public agencies and the academic institutions; comments on their infrastructure systems and issues faced during the project.
5. **Project Management Issues** - What technical issues and conflicts developed and how they were addressed by the team. Knowledge gained from the resolution of hardware, software, CAD integration and the project management issues will help NYSDOT in their future ITS work.
6. **Business Case for a Wireless Solar Powered Tag Reader System** - Did the project create a better understanding of the transportability of the solar powered tag reader, wireless communication, and hardware installation techniques? Did this project contribute to a better understanding of needs of local towns, cities, and states for traffic monitoring and management, and its potential commercialization? Did the project encourage the private sector to develop innovative, low-cost ETTM products?
7. **Project Expectations** - Conclusions on whether the ETTM project met the expectations of its sponsors and research partners, particularly the features and attractiveness of portability compared to conventional fixed tag readers in the varying weather conditions of the Northeast region. Is it even possible to develop ETTM products by partnering with private sector developer and manufacturer?

The following sections describe the key findings for the seven issues identified above.
3.0 Key Findings on the Request for Proposal Process

3.1 Background

The funding for this project was identified with a highway development project in the Capital District region, and this dedicated funding was allocated to create an ITS test-bed laboratory environment at RPI as well as the associated research. Once the funding was secured, NYSDOT prepared the Request for Proposal (RFP). The RFP process was overseen by the Transportation Infrastructure Research Consortium (TIRC), administered by Cornell University. Proposals were submitted in August, 2001. FHWA was the overseeing body and ensured that the project objectives were met.

This section outlines key issues encountered and lessons learned from the RFP Process used for this project.

3.2 Pre-proposing the Technical Solution

Although the RFP has no specific issue related to pre-proposing technology, the lesson learned earlier in the ATIS project (Ref.5) is again cited in the sidebar with additional observations as follows:

- In the future, NYSDOT and Emergency Management agencies should avoid proprietary solutions without provision for interface with non-proprietary technologies so that interoperability is not compromised.
- The lesson is that the desired “interoperability” must be “designed” into system engineering approach for multi-jurisdictional environment such as one in the Capital District region. The ETTM practice in the region was widely known to all and that helped the successful outcome.
- Technical (system) interoperability should be a key objective of an RFP process that involves multi-jurisdictions. Therefore project sponsors such as FHWA should ensure that federally funded development projects aim at creating awareness of the “interoperability” early on in the RFP process. This was the case in the ETTM project.

**Lesson Learned**

The lesson to be learned for NYSDOT and other agencies in the Capital District is to avoid pre-selecting any technology or vendor without proper investigation and provisions to investigate alternatives.

“It should be realized that vendor support for existing technology is essential and so is the migration path to new one”.

-Project Team
4.0 Key Findings on the Contracting Process

4.1 Background on TIRC Contracting Process/Mechanism

NYSDOT used an umbrella contract mechanism with TIRC (administered by Cornell University) to engage universities to conduct research projects. In order to create the ATIS project, including the TIM (Ref.1) and ETTM components, TIRC sent out request for proposals in July 2, 2001, which resulted in a fully executed ATIS contract on April 1, 2003.

Several project extensions were granted by TIRC and NYSDOT during the course of the project. In October, 2004, a revision to the contract was submitted to TIRC which included among other things an extension of the project beyond the expiration date of April, 2005.

The TIRC umbrella contract with NYSDOT was also expiring in August 2005, which meant the ATIS project could not be extended beyond that date. The extension to the ATIS project scope was not completed until October, 2005. During the period from April 2005 until October 2005, no expense vouchers could be processed by Cornell for the project team or its subcontractors. This ultimately delayed the signing of Mark IV’s subcontract until May 2006 when all of the paperwork was finally finished. The delay in the contract also presented a problem in securing the trailers for the project. This was because they could not be purchased until the contract was renewed with Cornell but when it was finalized the trailer vendor was out of stock and the team had to wait until stock was replenished. The project’s current work program, TIM and ETTM, is included in the revised scope of May 10, 2006, Amendment #4 (Ref.1).

4.2 Contracting Process for the Project

The project team and NYSDOT have reported that the contracting process used for this research was too slow, and caused significant delays in the schedule and frustrations to the team. The project reviews have shown that the slow pace of contract processing and changes in scope contributed to delays in the schedule.
In general research project such as this one probably should be given more flexibility to pursue intended objectives, particularly in a multi-jurisdictional setting.

4.3 Administrative Hurdles Encountered

In the early part of the ATIS project, the administrative hurdles at various levels (including at RPI, Cornell University and NYSDOT contract management) contributed to delays that could have been avoided with better administrative support. Previous report (Ref. 4) had outlined these concerns.

From the RPI standpoint, the following two general issues also had an impact on the ETTM project:

- The process with dealing with TIRC was time consuming and at times frustrating. For example, when contract modifications needed to be made it often took extreme lengths of time to get a revised contract.
- The complexity of the cost match was difficult to manage at times. Often many hours of administrative time was consumed in making sure this was properly documented. It is recommended that in the future for contracts of this magnitude the time for administrative purposes be included as cost match.

From Mark IV Industries standpoint, the following was noted:

For Mark IV, the most difficult contract process aspect besides creating the initial written proposal was mapping the progress payments into the overall project milestones and following RPI’s process for payment that necessitated a small amount of additional paperwork and the delays associated with the extra documentation. Also, there was some scope creep that Mark IV chose to accommodate without administrative change orders or additional charges.

4.4 Coping with Evolving Technology and Field Installation Issues

The ETTM project has shown that if the contract mechanisms are not adequately set in place to address the projects changing needs, evolving technology tends to adversely affect project management as well as the product’s developer (supplier). A key lesson is identified in the box below to minimize such adverse impacts.

This lesson also serves well for product developer such as Mark IV Industries, Inc. who must exhibit a great deal of flexibility and preparedness in new product development schedule and technical management, responding to new needs such as installing solar power and supporting wireless host communications (both outside of traditional methods).
- **Mark IV Industries, Inc.** - Mark IV is the sole source supplier of E-ZPass® transponders and the corresponding Automatic Vehicle identification (AVI) readers found in NYS and in 13 other states, and the developer of the mGate™ based tag reader for this project.

In May 2006, Mark IV began designing and building the first ETTM device. In this report the ETTM device or system refers to the mGate reader, antennas, and all other components. Mark IV’s role was to provide the mGate reader with the solar panels and provide technical and field assistance as needed.

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**Lessons Learned**

The project team should be prepared to act and remain flexible during project management: project managers should prepare contract mechanics to deal with a sudden need or change needed to respond to new situation on hand and to minimize further risks to progress. At the project management level, the team should remain flexible in decision making. This was amply demonstrated by both RPI and NYSDOT Project Managers. They had to remain flexible in dealing with the technical and installation issues related to solar power, antennas, trailer, cabinet and wireless interface for data transmission.

-Evaluation Team
5.0 Key Findings on the Project Team Partnering Process

5.1 Project Partners

The project partners in the ETTM phase of the ATIS were as follows:

- **RPI** - As the research team leader, RPI was responsible for the project management and experiment development.

- **Cornell University (TIRC)** – Provided contract administration with NYSDOT, developed the user information needs, and helped shape the experiment.

- **Polytechnic Institute of New York University** – Conducted the project’s evaluation and helped shape the experiment, and conducted tabletop exercises in other parts of the project.

- **Mark IV Industries, Inc.** - Mark IV is the sole source supplier of E-ZPass\textsuperscript{sm} transponders and the corresponding Automatic Vehicle identification (AVI) readers found in NYS and in 11 other states, and the developer of mGate based tag reader for this project. In May 2006, Mark IV began designing and building the first ETTM device. In this report the ETTM device or system refer to the mGate reader, antennas, and all other components. Mark IV’s role was to provide the mGate reader with the solar panels and provide technical and field assistance as needed.

- **NYSDOT/NYSTA** – Was the sponsoring agency and provided the project management and liaison with the FHWA. NYSTA provided support for data transmission from conventional tag readers in the area.

- **Annese and Associates** – provided data encryption algorithm and maintained data integrity for transmission, and coordination with NYSTA for their approvals.

- **John Wojtowicz Inc** – provided design and fabrication for the six trailers so they were compatible with the solar mGate hardware and provided storage and transportation of the devices as needed.

- **North Carolina State University** – provided technical support and assisted with data analysis.

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**Go for Innovation**

“NYSDOT should partner with private entities for innovation.”

- NYSDOT Project Manager
5.2 Challenges in Partnering

The assembling of an appropriate team to conduct research is central to a successful outcome. RPI had realized that the ETTM project demanded an experienced and willing partner to initiate the development and, later on, field test it.

The RPI team also realized that trust among partners was an essential ingredient in development of right team. The professional relationship that existed with Mark IV and RPI was instrumental in sharing interest in the main idea of this project and developing the initial scope of work that could be realistically pursued.

When this project was first conceived, the team’s priority was to find a partner that would be able to make it a success. Mark IV Industries, Inc. (Mark IV) was identified not only as the most logical but also as the only partner that could offer the materials needed. Mark IV is the sole source supplier of E-ZPass® transponders and the corresponding Automatic Vehicle identification (AVI) readers found in NYS and across 13 other states.

Mark IV was interested in partnering with RPI on this project as it promotes the use of their technology while expanding the coverage of the highway network. Thus the challenge to find a suitable partner with a research focus matching the objectives of the ETTM project was successfully met by having Mark IV as the developer of the mGate reader. In addition, Mark IV had the capability of managing risks and technical issues.

Lesson Learned

“The right partner, in this case, Mark IV, was willing and able to bring the development forward.”

“Mark IV placed a significant focus on the ETTM development and we were aware of their resourcefulness”.

- RPI Project Manager
6.0 Key Findings on Project Management Issues

6.1 General

To ensure the successful outcome of this research project, the project team made a concerted effort to exercise a great deal of flexibility during the organization of the experiment, selection and acquisition of the component technologies and implementation, and conduct of the experiment.

Despite the senior staff turnover and student team members moving on at RPI, both the first project manager and his replacement—the current project manager provided remarkable continuity in project management was maintained.

Mark IV also reported that the RPI project had clarity of purpose and there was good sense of who is doing what and how it will come together. They found that this project was more complicated than their normal work, but were happy to work with RPI.

6.2 Project Coordination

Project coordination among public and private sector members was well maintained in the ETTM work. Reports and documents were prepared to keep everyone informed about the progress and status of the overall project.

This is a significant success in a research-oriented project. Efficient coordination of everybody’s experience and inputs across sub-tasks is an excellent mechanism to keep everybody involved, like true stakeholders. These mechanisms also heighten everybody’s sense of responsibility for the successful conduct and outcomes.

This development and field experiment has shown that for a successful outcome, good project management, coordination and, above all, communication are the essential ingredients for succeeding in an uncharted area of research.

6.3 Resolution of Technical Issues

The evaluation team met with both the RPI team and Mark IV to share technical issues encountered during the prototype development and how they were resolved.

Technical Issues

During the course of project development, Mark IV and the RPI team faced the following issues:

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Lesson learned

“This RPI project provided an example of how DOTs and other government agencies can work together to devise an institutional framework to adopt necessary change in the region. This project provided an implementable knowledge not otherwise forthcoming”.

-NYSDOT Project Manager
• Mark IV faced the challenge of providing a solar powered reader that is normally AC powered, with no prior in-house experience working with solar/battery systems.
• Providing a means to operate new units autonomously for an extended period of time, without any AC power.
• Scope changes to support recharging of peripheral devices, for example a laptop computer to store data.
• Facilitating the provision of restricted technology to a third-party.
• Achieving reasonable system performance using devices that were designed for use with lower speed traffic rather than highway speed traffic.

Resolution of technical Issues

• Mark IV developed in house knowledge by polling solar power vendors, and hired a project manager. They actually worked a bit outside of their normal processes to develop a system where they do not normally undertake such tasks for outside clients.
• Mark IV took educated guesswork on what power subsystem would be adequate for the demonstration including solar panels.
• Mark IV provided the means to demonstrate the concept with a caveat as to the severe limitations of the solution.
• RPI negotiated with the toll agency (NYSTA) for access to the data from the transponders deployed in the area as well as dealing with privacy issues that resulted in additional encryption effort by the project team.
• Significant concessions were made by Mark IV, compared to normal business practice. These included: including revision to operating code of device; allowance for antenna aiming by a third party; allowance for mis-mounting of antennas due to limits of infrastructure locations available; allowance for limited performance margin; allowing a relatively low-performance system to be used. (According to Mark IV, they would normally never offer to sell a system with the potential for poor performance because their reputation in the E-ZPass® world relies to a degree by the past record of excellent system performance.)
• Originally the team was going to mount the readers on utility poles or other fixed structures. Rather than seek permission from the utility companies the RPI team opted for the trailer mounted design which eliminated the need to contact the utility companies. The RPI team then worked closely with the NYSDOT and the land owners to gain permission to deploy the trailers along the road.
• There were several cases where the team decided to deploy the readers but it was not feasible to get the trailer in close proximity to the road. In these cases RPI worked with NYSDOT to gain permission to mount antennas on road signs.

Communications Issues

• Design flexibility and innovative approaches also worked for a problem encountered by the Pocket PC which does not support a RS 232 port which mGate has for data transfer. This problem was quickly solved by attaching an inexpensive AIRCABLE to mGate to transmit data via Bluetooth.
• Data integrity was also resolved by making only pre-configured Bluetooth devices for data transfer, thus eliminating unauthorized port.
• Mark IV assisted the team in securing the proper FCC licenses for the readers.

Issue of Data Fusion

• The project was to compare data collected by in vehicle probes with Pocket PC with data supplied by mGate reader. However, due to a lack of interest on ATIS probes participation by drivers and project time constrains, the project team dropped the concept of data fusion process to compare accuracy.
• The evaluation finds that the above concept of data fusion is not a core issue to demonstrate the viability of the portable system as the system has clearly performed as shown by travel time data collected through manual means.

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7.0 Key Findings on the Business Case for a Wireless Solar Powered System

7.1 Introduction

*Did this project help in making a business case for wireless solar powered tag reader deployment?*

This question is answered with the following three concerns in mind:

- Viability of reader as a transportable infrastructure from the owner’s standpoint (NYSDOT)
- mGate E-ZPass® tag reader as an emerging but deployable product from the manufacturer’s standpoint (Mark IV Industries)
- Readers field performance (mainly data accuracy, high speed, multi-lane detection) under all weather conditions in NYS region.

7.2 Business Case as a Wireless Solar Powered Infrastructure

From the transportation infrastructure point of view, the portability feature has given an affirmative indication of the viability, deployability and performance under varying weather conditions. Therefore for the NYSDOT, private sector partners, and research team members, the business case is made. They believe that the project has shown how “thinking outside of the box” can create a better understanding of the new tag reader infrastructure that uses green energy and modern wireless methods, all helping to keep cost at minimum. Previously no such consideration was given to ETTM technology.

Furthermore, this project has made NYSDOT realize that the emerging wireless infrastructure and solar panels are workable, so the agency need not be engaged in such infrastructure development itself. There was a strong feeling that the State should not in any way compete with the private sector, but rather should partner with them to develop such services. The thrust behind this conclusion is that the State’s mindset of infrastructure ownership is changing.

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**Key Finding**

“This project has successfully demonstrated the viability of a transportable reader system alternative for traffic monitoring applications where conventional readers are not practical to erect.”

“Who is going to take this on to start a business?”

“As public agencies are looking to cut costs they may create a market for transportable readers.”

-RPI Project Manager
NYSDOT feels that the traditional traffic detection and monitoring means used for data gathering for ITS user services within ATMS/ATIS applications can be provided with mGate readers coupled with a wireless communication interface. Such an approach is less expensive than the ETTM-TRANSMIT type of installation in which one needs do trenching to lay conduits – a costly installation.

**7.3 Business Case as a Viable New Product**

Recognizing that conventional readers used in the United States for ETTM and TRANSMIT applications are widely and satisfactorily deployed, it was important to examine the intent of the manufacturer to engage in the development of mGate-based reader technology whose market potential or even commercialization is an untested area.

As stated earlier, the leaders of the RPI project team had encouraged Mark IV to partner in the development of the new mGate reader on the basis of anticipated public agencies needs in traffic monitoring where conventional applications are not practical.

Mark IV had placed trust in the project in earnest, based on prior professional relationship with RPI and prior experience with the ETTM applications in the State and region.

Mark IV added the following observations:

- Subsequent to the project completion (six mGate reader units were sold to RPI), Mark IV has not sold any new devices and there have been no serious inquiries.
- Mark IV stopped all development of the solar powered mGate reader once the project deliverables were completed, as there was no feedback from NYSDOT about the prospects for supplying additional units.
- Mark IV Industries reported of at least one consultancy who has noted the existence of the new technology from presentations made at ITS NY and ITS America and they have incorporated this mention into its own presentation materials.
- TRANSCOM, the key user of the TRANSMIT system for traffic monitoring has expressed a preference for the conventional high performance, ground-fixed, multi-lane version of the tag reader technology, although they would consider a solar powered version if one is developed. TRANSCOM has indicated that they cannot make use of the solar mGate tag reader as currently designed.
- Mark IV Industries stated that they have shared recognition at ITS NY for an ITS project of the year award. They are proud of that award as it symbolizes their creativity and technical expertise, which doesn’t often get shared with outsiders. This again speaks well for the RPI partnering process.

**Key Findings**

“Mark IV would not have undertaken the project were it not for the RPI.”

-Mark IV Project Manager

“Securing early-on commitment of all partners is the basis of successful outcome.”

-RPI Project Manager
7.4 mGate based Reader Applications for Traffic Monitoring

This evaluation finds that the concept of the solar mGate significantly changes the equipment strategy for traffic monitoring applications. The new reader has brought to the attention of the public sector the overall lower cost and its field adaptability for traffic management applications. This makes it more affordable as opposed to deploying traditional readers which require power and communication infrastructure. Preliminary estimates indicate that these devices may cost up to 75% less to install than a fixed installation cost.

The project tested six units successfully along US Route 4 in North Greenbush, New York in and at the NYS Fair in Syracuse. The device was deployed along an arterial, at a special event and work zone to monitor travel times during all types of weather conditions such as hot humid days, severe rain and wind as well as snow and ice.

According to the NYSDOT, the side-fire design of the new reader covers fewer lanes as compared to the conventional reader. The device has not been tested in the overhead application to see if the results are similar to the conventional reader.

Building on their positive experience of the ETTM project, the NYSDOT has shown interest in deploying transportable tag reader system on I-787 and potential work zones areas in the future.

Lesson Learned

“The ETTM project has opened our eyes to possibilities in ITS in general, where towns, cities and states can benefit from low cost affordable transportable transportation infrastructure for traffic management.“

–Michael Schauer
FHWA, Albany
8.0 Key Findings on Project Expectations

8.1 NYSDOT Expectation

NYSDOT’s expectation from this phase of the research project has been met with the realization that it is possible to forge a partnering arrangement for research on new products that offer lower cost and wider application for traffic monitoring. NYSDOT has also expressed satisfaction that working with capable researchers can result in an enhanced product as demonstrated by the RPI team which succeeded in meeting research needs for devising quick solutions as the problems arise.

For example: where and how to mount antennas, and how to store and transfer data by wireless interface, and trailers for portability. At this time NYSDOT has no plans to extend the work done to a new level. But it intends to consider the transportable reader system for work zone management applications at I-787.

8.2 Private Sector Expectation

Mark IV has clearly indicated that lessons learned and expertise gained in developing an innovative product such as this transportable system are lost, as the project ends and interest vanes. In a short time one loses what was gained, and relearning is costly.

Although Mark IV is willing and prepared to commercialize this product, without market interest, they cannot invest in the product cycle at this point. Thus the value of research and investment in the entire project will be lost without the next step to continue the process.

8.3 Research Expectation

The initial research by RPI created a path to a development phase: the project began with an investigation of possibility of a new reader that can evolve around agencies’ needs, and ended with a system that not only meets needs, but also uses innovation as a basis for its development. In this context, this research has exceeded the expectation.

In conclusion, this evaluation finds that the project has successfully met its intended objective to develop and field test six prototype wireless solar powered E-ZPass® tag readers.

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**Key Finding**

“ETTM was a very narrowly focused project that produced a viable transportable stem. RPI did a fine job managing”.

-NYSDOT Project Manager

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**Lesson Learned**

“The ETTM project was a good attempt to understand underlying field issues in creating a portable system with a new reader. The portable infrastructure is coming to an age.”

-RPI Team
The results have shown that these units can be configured as transportable reader system which can be moved at any time and any place for traffic monitoring applications for work zones, special events management, etc.

Data collected from the field tests have shown that the reader system is reliable and can withstand weather and installation conditions in NYS, and demonstrated its accuracy at high speed traffic.

In conclusion, the project team, NYSDOT, and Mark IV have concluded that the transportable reader system concept is a highly feasible with a potential for commercialization.
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