Advanced Traveler Information System (ATIS) Implementation and Integration: Final Report

Research Number: Z-01-02
Research Study: Advanced Traveler Information System (ATIS) Implementation and Integration
10/06

Consultants/Organizations:
Rensselaer Polytechnic Institute
Cornell University
Polytechnic University
North Carolina State University
CUBRC / GD – AIS
Annese and Associates
Consensus Systems Technologies
ALK Technologies

Abbreviations & Acronyms

3G – Cellular industry abbreviation for third generation systems
ALK – ALK Technologies, Inc.
ATIS – Advanced Traveler Information System
AVI – Automatic Vehicle Identification
AVL – Automatic Vehicle Location
CDTA – Capital District Transportation Authority
ConSysTec – Consensus Systems Technologies
CUBRC/GD – Calspan – University of Buffalo Research Center / General Dynamics
DFD – Data Flow Diagram
DSRC – Dedicated Short Range Communication
FHWA – Federal Highway Administration
GPS – Global Positioning System
HAR – Highway Advisory Radio
HVCC – Hudson Valley Community College
ITS – Intelligent Transportation System
NYSDOT – New York State Department of Transportation
Poly – Polytechnic University
RFP – Request for Proposal
RPI – Rensselaer Polytechnic Institute
TIRC – Transportation and Infrastructure Research Consortium
TMC – Traffic Management Center
TOC – Traffic Operations Center
USDOT – United States Department of Transportation

<table>
<tr><td>1. Report No.
SPR#: C-xx-xx</td><td>2. Government Accession No.</td><td colspan="2">3. Recipient's Catalog No.</td></tr>
<tr><td colspan="2" rowspan="2">4. Title and Subtitle
Advanced Traveler Information System (ATIS) Implementation and Integration: Final Report</td><td colspan="2">5. Report Date
October 2006</td></tr>
<tr><td colspan="2">6. Performing Organization Code</td></tr>
<tr><td colspan="2">7. Author(s)
Alixandra Demers, Earl E. Lee, Jeffrey M. Wojtowicz, William A. Wallace, and George F. List</td><td colspan="2">8. Performing Organization Report No.</td></tr>
<tr><td colspan="2" rowspan="2">9. Performing Organization Name and Address
Rensselaer Polytechnic Institute
110 Eighth St.
Troy, NY 12180</td><td colspan="2">10. Work Unit No.</td></tr>
<tr><td colspan="2">11. Contract or Grant No.
Z-01-02</td></tr>
<tr><td colspan="2" rowspan="2">12. Sponsoring Agency Name and Address
NYS Department of Transportation
50 Wolf Road
Albany, New York 12232</td><td colspan="2">13. Type of Report and Period
Covered
Final Report</td></tr>
<tr><td colspan="2">14. Sponsoring Agency Code</td></tr>
<tr><td colspan="4">15. Supplementary Notes
Project funded in part with funds from the Federal Highway Administration.</td></tr>
<tr><td colspan="4">16. Abstract The ATIS project was a $1.3 million effort sponsored by the Federal Highway Administration and the New York State Department of Transportation. The project began in March, 2003 and completed in May, 2007. The goal of the project was to create a real-time, probe-based traveler information system, including traffic-responsive path choice. In order to accomplish the goals, vehicles were equipped with GPS and wireless data connections and became traffic probes. Observations were collected from the probes as they traveled through the network, and these data were processed into traffic conditions on the network. This processing was done in "real time", in time to provide information to the vehicles support decision making regarding path choices to avoid congestion. Two hundred probe vehicles were deployed in the Spring of 2005. The project was the first live demonstration of this concept, having moved the idea from the lab and simulation to the real world. The project received two awards from the Intelligent Transportation Society of New York and is a finalist for the 2007 Best of ITS award from the Intelligent Transportation Society of America.</td></tr>
<tr><td>17. Key Words
ATIS, ITS, probe vehicles,</td><td colspan="3">18. Distribution Statement
No Restrictions</td></tr>
<tr><td>19. Security Classif. (of this report)
Unclassified</td><td>20. Security Classif. (of this page)
Unclassified</td><td>21. No. of Pages</td><td>22. Price</td></tr>
</table>

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1 Executive Summary

The Advanced Traveler Information System (ATIS) Implementation and Integration Project began in August 2001 with submission of the original response to request for proposal Z-01-02. The goal of the project was to create and field test a wireless ATIS. Contract award and administration were completed in March 2003. Research and planning functions for the project were conducted from March 2003 to January 2005. The field experiment was conducted near Albany, NY for the next three months (February 15th to May 15th). Upon completion of the field experiment, compilation of the probe data as well as other data sources was conducted, followed by in-depth analyses. This final report is the culmination of the project-related work.

This final report includes an introduction, the research methods, the findings and conclusions, and a statement on implementation. The introduction covers the project goals and vision. The research method section covers the collection of information that led to the final design of the system along with the design of the field experiment. This section includes tasks 1 through 7 including tasks X1 and X2. The findings and conclusions section covers task 8. Task 9 focused on implementation.

2 Introduction

The goal of this project was to create and test a wireless Advanced Traveler Information System (ATIS) using the ITS Test Bed Laboratory as the experimental environment. The test bed area is in upstate New York east of Albany and south of Troy incorporating both arterials and expressways; it is bordered by the following roads: Route 378 to the north, Interstate 90 to the south, Route 4 to the east, and Interstate 787 to the west. The area is populated by residential, commercial, and office developments including two large trip generators (Rensselaer Technology Park and Hudson Valley Community College). The original intent was for a system that was designed to meet the needs of the highway users and transit customers in the project area and aid the transportation operating agencies in meeting those needs. In addition, a regional ITS architecture had to be developed. The architecture addressed research projects and allowed for flexibility during the conduct of the project while requiring compliance before any permanent deployments.

As stated in the work scope, the original goals were to:

- Ascertain the information needs of highway and transit users
- Determine what data items need to be collected to meet those needs
- Develop mechanisms for collecting those data items, processing them into the information needed, and disseminating that information to the highway and transit users
- Investigate ways to use wireless technologies to track the movement of the highway and transit users and convey information to them which is useful in travel decision making
- Integrate this process into the existing Capital District ITS activities (e.g., through the Traffic Management Center)
- Ascertain the lessons learned from the project
- Assess the costs/benefits of deploying the wireless ATIS system across the entire Capital District

3 Approach and Methodology

Tasks 1 through 7 involved the collection of information necessary to understand the needs of the intended users; the types of technology available; and the design of the experiment. A summary of each task is provided below generally in chronological order.

3.1 Task 1: Develop Regional (Capital District) ITS Architecture

A regional ITS architecture was needed, so Task 1 was included to meet this requirement. Having developed the New York State architecture, Consensus Systems Technologies, Inc. (ConSysTec) was chosen to develop the regional plan. The products of Task 1 can be found at the following website: http://www.consystec.com/newyork/capitaldistrict/capital/capitalintro.html.

3.2 Task 1X-1: Determine User Information Needs

The project team saw the importance of learning about the customer (travelers) prior to making key decisions about data and information that would impact the choices of the project technology. Therefore, Task 1X-1 was designed to find out from the intended group of users the current practices and communications devices used and owned and their potential for using a communication device for routing assistance. The survey instruments were designed by Cornell, distributed and the results compiled by RPI, and analyzed by both Cornell (private commuters) and RPI (commercial dispatchers and drivers). The main components of the surveys were:

- Demographics
- Travel habits
- Communications access
- Communications use
- Information needs
- Information uses
- Potential use of an in-vehicle communication system

The results of this task brought to light that transit was used by less than 5 percent of survey respondents that reduced the need to focus on a transit ATIS. Also discovered were rather short commute trip travel times (on average, less than 30 minutes) that turned out to affect link coverage rates by probes during the experiment (see Tasks 6 and 8). Furthermore, each driver on average knew less than 3 alternate commute routes – possibly because of short trip lengths. Hence, en route travel time information used to generate alternate routes for drivers was deemed important to include in the soon-to-be developed ATIS.

3.3 Task 1X-2: Determine the Data Needs

With the ITS architecture specified in Task 1 and user needs and characteristics determined in Task 1X-1, Task 1X-2 commenced in June 2003 with the goal of translating drivers' needs into data needs and user-system interactions communicated via data flow diagrams (DFDs). Three such DFDs were created, one for each state a driver would be in: pre-trip home/office, pre-trip in-car, and en route in-car. These DFDs would guide the technology decisions, especially the composition of message packets transmitted between the user devices and a main server. The other major result of Task 1X-2 was a table listing the data flows possible before and during a trip. Ten data flows were identified, four of which were developed as part of this ATIS project. Of those unrelated to the project, drivers may have encountered information from commercial radios and HAR, for example. The project data flows included:

- Origin/destination data from driver to computer
- Position, speed, direction of travel, and time data from computer to the traffic operations center (TOC)
- Link travel time estimates from the TOC to computers
- A route recommendation from the computer to a driver

This data flow process was further refined in Task 2.

3.4 Task 4: Create the Data-to-Information Process and Task 5: Create the Information Dissemination Process

Building upon previous work and occurring concurrently within Tasks 1X-1 and 1X-2, Tasks 4 and 5 included analysis of both traffic data collection and information dissemination technologies that could meet the driver's needs that were being documented in Task 1X-1, and meet the data needs being outlined in Task 1X-2. The work completed during Task 4 included reviews of existing traffic sensors as well as the available wireless and GPS based technologies. Task 5 focused on how to deliver information to the drivers. The strengths and weaknesses of each sensor type were evaluated. This task was led by RPI and supported by a technology review by CUBRC/GD for both Tasks 4 and 5.

3.5 Task 2: Instrument the Highway Network

Task 2 had two subtasks, (1) choose the technology to instrument the network, and (2) create the instrumentation plan. Since the chosen in-vehicle technology (pocket PCs) was different from that originally anticipated (cell phones), this task was conducted by RPI instead of CUBRC/GD.

The original work scope specified the use of the U.S. Wireless system. With the business failure of that company, a new instrumentation method had to be found. Wireless methods to instrument the highway network were explored to fill this need. Three systems were based on cellular phone technologies (triangulation, multi-path location identification, and GPS-equipped phones). Cell phone location monitoring data is proprietary information and not releasable for use outside the respective cellular provider or law enforcement. Therefore, a fourth option, that of a PC or pocket-PC based route guidance system was explored and a decision was made to use the CoPilot Live system made by ALK Technologies, Inc. with the addition of new data transmission and retrieval functions and modification of its two-way communication system. Specific requirements were developed by the project team to convert the existing commercial product into the dynamic, route guidance package envisioned by the project team. Modifications were later needed so that probe travel times could be measured, processed, and shared among the drivers.

Following the technology choice, the instrumentation plan was developed. In short, it covered device distribution decisions, data transfer steps and purpose, and system monitoring abilities.

3.6 Task 3: Instrument the Transit Network

In Task 3 the region's transit operator, Capital District Transit Authority (CDTA), was contacted to determine the current state of their network's traveler information capabilities. Since the development of the original work scope, CDTA had begun an upgrade of their system. This new system included AVL technology in the buses, voice over Internet protocol communications between drivers and dispatchers and many other system upgrades. However, their current IT projects were not at a stage when they could be integrated with this project. Furthermore, it was found that their vehicles did not travel the test bed corridor frequently enough to be strong contributors to the ATIS project. A technical report documenting the above information was prepared as a task deliverable. CUBRC/GD was to have primary responsibility for this task, assisted by RPI; however, with work scope changes RPI conducted this task without CUBRC/GD input.

3.7 Task 6: Organize the Experiment

A critical task for the project was Task 6, the organizing of the project at a detailed level by thoroughly addressing three issues:

- How must instrumented vehicles (probes) be distributed throughout the network to yield adequate link coverage for travel time estimation (this included examination of potential participants' origin-destination matrices and creation of an appropriate real-time, travel time estimation method)
- How must user data be collected, processed into information, and disseminated
- What performance metrics should be chosen to best capture such items as user perceptions of the system and hardware and software performance

This task was started in June 2002 when the development of a traffic simulation model of the test bed began and was not completed until December 2004 (just before the start of the experiment) when the data collection and processing were finalized and tested. This task was to be led by RPI for the system and by Cornell for the users with secondary assistance from CUBRC/GD on the system. Because of work scope changes regarding the chosen technology, the task was instead completed by RPI with secondary assistance from ALK and Cornell.

3.8 Task 7: Implement the ATIS System

When Task 6 was nearing completion, the system components were acquired and assembled for Task 7. This task was conducted by RPI with system integration assistance from Annese & Associates, Inc. Driver equipment included Pocket-PC's, memory cards, GPS devices, wireless web cards, the CoPilot Live software, and the CabBackup 1.3 software. System equipment included a central server, office space for an operations center, and necessary software. In addition, some field equipment (radar guns and automatic traffic counters) was acquired for collecting supplemental data. When the route guidance equipment arrived, it was assembled into 250 sets, one for each volunteer participant (driver) and readied for distribution during Task 8.

4 Findings and Conclusions

4.1 Task 8: Conduct the Experiment

Task 8 was started in June 2004 and completed at the end of 2006 with the submission of the final technical report. The task was conducted by RPI with assistance from ALK. The task's purpose was to carry out a multiple-month experiment to evaluate an advanced traveler information system. Prior to the experiment, there were two subtasks, (1) select appropriate participants, and (2) develop and test the system to debug it prior to deployment. Then, the experiment ran from February to May 2005 with approximately 200 participants from HVCC and the Tech Park driving probe vehicles throughout the Capital District Region. They were receiving up-to-the-minute fastest route directions for each of their trips based on a travel time estimation algorithm that pooled data from all the probes. At the conclusion of the experiment, the data (from surveys, the server, and pocket PC memory cards) were compiled, cleaned, and analyzed based on the performance metrics developed in Task 6. An in-depth discussion of the findings is in the Task 8 technical report with select ones mentioned here.

- It is clear from the data that the Tech Park participants were more reliable users of the ATIS than the HVCC participants; there were many days when more than 60 percent of the former were driving during the required 6 to 9 AM period. In fact, with only a few exceptions, the Tech Park participants used the devices 30 or more days each whereas only about 28 percent of HVCC users logged on in the AM period 30 or more days. Fueled by the low usage rates by HVCC participants and the project limit of 200 deployed devices, probe penetration rates were lower than hoped in the test bed area with less than 2 percent of the traffic being probes at some key locations where 5 percent was anticipated as necessary for good travel time estimation. However, based on speed comparisons of ATIS sources with a sample of traditional sources (automatic traffic recorders, radar guns), the ATIS sources were found to give accurate results.

- During events causing road closures, the research team drastically increased travel times on blocked links manually so they would not inadvertently be selected for shortest paths by the routing algorithm (and then returned them to normal levels upon link reopening). This action illustrates the need to include non-probe data so that the model can run without operator intervention.

- A conservative estimate of the possible participant-experiment days lost due to component failures is 6.5 percent (714) of the approximate 11,000 total participant-experiment days.

- Before and after the experiment, users were surveyed on how the ATIS worked for them. Summing up the survey results, overall, the users stated that they trusted the system and that by the end of the experiment the device was giving them accurate directions most of the time. Unfortunately, and possibly due to the network selected and the chosen travel time estimation algorithm, participant responses were mixed when asked whether they thought that the system routed them around congestion.

Future findings are anticipated as ongoing research beyond the scope of this project is continued with the available data and data from the upcoming Electronic Toll and Traffic Management project, also with NYSDOT.

4.2 Task 10: Deploy the ATIS System Region-wide

The original work scope included the use of a fixed-sensor system, specifically the Radio Camera technology of U.S. Wireless. Task 10 was intended to support the regional deployment of that system, if additional funds became available. However, with the final technology choice being a vehicle based system and cellular communications, the project moved from a system where transportation agencies own the sensors to a paradigm where those agencies now become the users of the data provided. Under this new paradigm, the deployment will be based on outside entities, such as wireless service providers. This is discussed in greater detail in the Task 9 report.

4.3 Task 11: Prepare the Evaluation Report

This task is being conducted by John Falcocchio of Polytechnic University. It began in March 2005 just after the start of the field experiment. An evaluation report is being prepared to evaluate the processes used during the project. It will include an evaluation of issues including the effectiveness of the partnering relationship, the effectiveness and means used to resolve technical issues, and techniques used with private partners including finance.

5 Statement on Implementation

This statement on implementation is based directly on the results of Task 9 of the project. Unlike typical statements on implementation, this one is in the form of a picture of what is in the future for ATIS deployment rather than a specific plan for the NYSDOT to implement because, based on this project research, the agency is not foreseen controlling deployment but rather being one of many participants collaboratively guiding it.

5.1 Task 9: Develop a Regional Deployment Plan

Task 9 was started in March 2006. This task was conducted by NCSU and RPI. In the original work scope, the use of cell phone technology was anticipated which would have required a large-scale capital investment and careful planning by an agency such as the NYSDOT. However, GPS and wireless communications technology were used for the field experiment that are guided by consumer choice in device types and services acquired with little or no action by the NYSDOT necessary. Therefore, the Task 9 report discusses the implications of this finding and how public agencies can encourage the growth of the ATIS market as well as participate in it.