COMPETING WITH THE GHOST OF *ADVANCE*: EXPERIMENTING WITH REAL-TIME ATIS

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ABSTRACT

In the early 1990's, the in-vehicle navigation and route guidance project called *ADVANCE* was underway in the northeastern suburbs of Chicago. The final field experiment included 70 households and 110 drivers for approximately 2 weeks, it proved that travel time data could be updated on in-vehicle devices (albeit not in real-time) to assist drivers in choosing faster routes to their destinations.

Since the time of *ADVANCE*, there has been significant simulation-based research about providing probe vehicles real-time information to improve route guidance. However, field experimentation has been lacking, in part because available technology is only now catching up with our ideas. Recently, a 3-month field experiment was conducted in upstate New York with just under 200 participants that used in-vehicle route guidance technology in conjunction with GPS locators and real-time, link travel time updates. Two-way communication between the vehicles and a central server was key and provided through a wireless communications network. Link travel times were recorded by the probes, updated on a central server, and queried by the individual probes every minute of their trips. Hence, each probe driver relied on all the other probes in the network to provide travel time information. In all, the experiment resulted in a total of 4,111,210 latitude-longitude and position-speed-date-time points. The largest number of location points per user was 98,018 while the smallest was 117 points. The average per user was just over 26,000 location points, or 325.5 points per trip. In terms of probe trips, there were 12,629 trips for a traveled distance of 147,316 miles over a duration of 3,945.8 hours.

This paper includes a detailed discussion of the Capital District ATIS project while showing some parallels and differences with the last field project, *ADVANCE*. Areas covered by the authors include: project background, description of the test bed area, participant statistics, experiment design, sample results, and future research directions.

INTRODUCTION

In the early 1990's, the in-vehicle navigation and route guidance project called *ADVANCE* (**A**dvanced **D**river and **V**ehicle **A**dvisory **N**avigation **C**onc**E**pt) was underway in the northeastern suburbs of Chicago. Planned as a huge field project with hopes for 3,000 to 5,000 volunteer drivers testing equipment over 4 years, *ADVANCE* included a host of public and private agencies working as a team, and led by the Illinois Institute of Technology, to carefully develop the experiment. Although the final field experiment included only 70 households and 110 drivers for approximately 2 weeks, it proved that travel time data could be updated on in-vehicle devices (albeit not in real-time) to assist drivers in choosing faster routes to their destinations (De Leuw 1997).On a weekly basis, the updated travel time data was downloaded to the vehicle computers. As a result, path choice was enhanced because real travel times, derived from vehicle observations were being used instead of defaults or simulation-based estimates. Since then, no project has tried again to both use vehicles as probes and feed them back traffic information.

In Spring 2005, the Capital District Advanced Traveler Information System (CD-ATIS) project was conducted in upstate New York, led by the authors, with 200 volunteer participants driving their own vehicles, specially equipped with route guidance equipment, for 3 months. The project was planned as a test of probe vehicles as data collectors and as information receivers. The in-vehicle devices shared real-time travel time data (updated every minute via a server) to improve each probe's trip through route recalculation and reselection based on the quickest travel time from the current location to their programmed destination.

The authors describe here an overview of the project and how it compares to the ADVANCE project of a decade ago to give readers a sense of context. The experiment is described in terms of the study area, design, and participant selection. Next, results that can be extracted are mentioned followed by some sample results at the macro level. Finally, the paper is closed with mention of the researchers future directions of inquiry noted.

PROJECT BACKGROUND

Similar to the *ADVANCE* project's "pioneering effort" (Argonne National Laboratory 1997), the CD-ATIS project was a joint public-private venture. Fourteen agencies in all joined together led by Rensselaer Polytechnic Institute (RPI) and funded by the Federal Highway Administration and the New York State Department of Transportation, to make this experiment happen. The project budget was $1.4 million, significantly less than *ADVANCE*'s estimated $35 to 42 million budget (Boyce 2002).

The primary goals of the projects were also quite similar with a focus on testing real-time probe data collection while offering route guidance to said probes. One distinction is the expectation for how often updated real-time information is relayed back to the probes (one or more weeks for *ADVANCE* compared to one minute for this project, although more frequent messaging was initially planned for the former). Another distinction is the scope of the projects in both size and purpose. *ADVANCE* was planned for 3,000 to 5,000 participant drivers while the CD-ATIS project aimed for a modest 200 participants. Although the main goal was to conduct an operational test, *ADVANCE* had a broader purpose to fuse data from multiple sources for dynamic route guidance whereas the CD-ATIS project solely focused on probes sharing travel time data with one another to improve their route guidance. In contrast, the *ADVANCE* study area was in a dense urban area (Chicago, IL with 750,000 people in 300+ square miles) while CD-ATIS was in a larger suburban area (1,000,000 people in 5,000 square miles).

Comparison of the technologies used and the method of data transmission and updating for in-vehicle route guidance.

Test Bed Area

The CD-ATIS experiment was focused on a small region of Troy and North Greenbush, New York as shown in the inset of Figure 1. Commuters and students flock to this region on weekday mornings for two main traffic generators, the Rensselaer Technology Park ("Tech Park", an office park) and the Hudson Valley Community College (HVCC). Plus, there were limited routes to access these two locations so that our team could easily monitor changes in traffic patterns, such as those due to incidents.

To enable the participants of the experiment to reach the test bed area and travel within the region for other trips, an approximate 40-mile radius study area (Figure 1) was programmed into the navigation software, a beta version of CoPilot by ALK Technologies, Inc. In Figure 1, the large black and white symbols indicate highway routes while the small black dots indicate "monuments" (think of these as virtual toll gates) programmed into the software as checkpoints for travel time estimation. With the study area established, the focus turned to experiment design and participant selection.

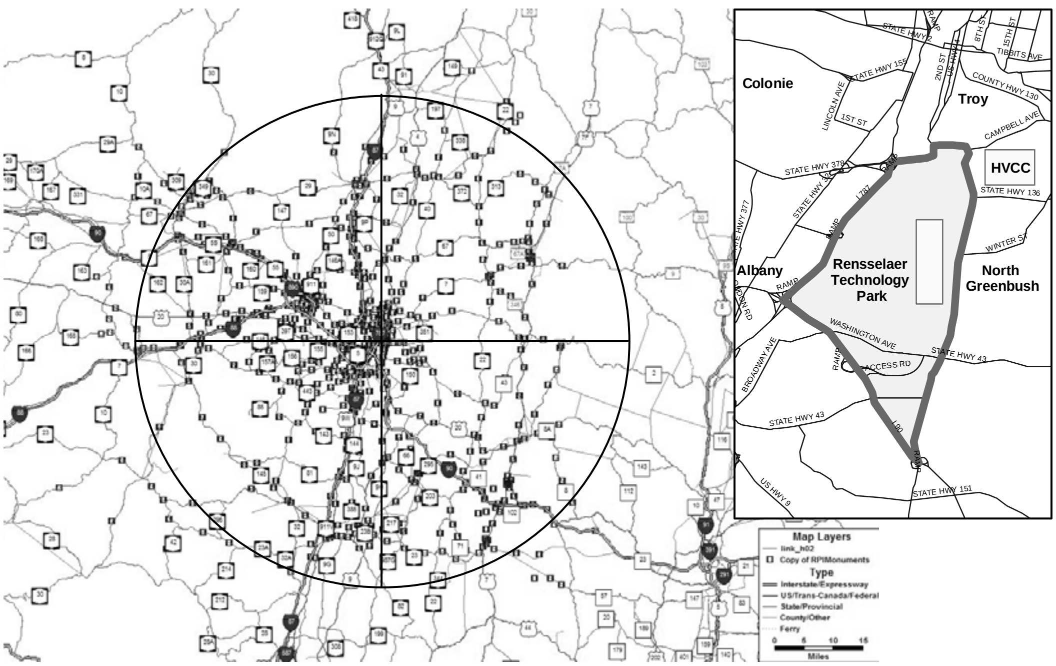


Figure 1 Study Area and Test Bed Location

Experiment Design

Data collection with probes can be dicey, as found in *ADVANCE*. With a limited number of equipped vehicles, the desired network of roads must be covered by the probes. Hence, a small study area may be desirable. Additionally for the data to be useful, multiple probes must cover the same arc under similar travel conditions to obtain reliable travel time estimates. If one probe covers a link at 7 a.m. and another at 4 p.m., then the data are useful for historical purposes but less so for real-time, travel time estimation since the traffic flows are likely quite different. In the ADVANCE project, a short section of a single arterial was used to develop travel time estimates with 12 probes traveling the section at the same time

(Sen, Soot et al. 1996; Saricks, Schofer et al. 1997?). The CD-ATIS team chose a small network and planned to work with 200 probes. Therefore, the team selected the time period of interest to be the morning commute, 7 to 9 a.m. weekdays, anticipating this time frame to have the highest number of travelers with regular origin-destination travel patterns. To further improve expected probe densities on the arcs of interest, the team conducted probe density simulations based on different origin scenarios, assisting in the selection of volunteers which was partially based on their geographic home.

Trait	***ADVANCE***	**Capital District ATIS**
Travel time estimation	Link Travel Time Process Simple with fast decay function _________ algorithm	Exponential smoothing algorithm
Traffic Mgmt Center	Central processing facility with operator interface	Run by RPI personnel, fully staffed during the morning commute. Included system observing in mornings and 24-hr Help Center for participants.

Participant Selection

With the test bed area selected, the experiment was designed to capitalize on the heavy morning commute travel patterns in the Capital District area of New York (Albany, Troy area). As such, from a pool of applicants, participants were selected because they made early morning (8 a.m.) trips to either HVCC or the Tech Park, highlighted in Figure 1's inset. The notion was that these travelers would benefit from the travel times of their fellow participants and that the quality of information would increase as the morning progressed.

Three cohorts for a total of 201 participants were included in the experiment. The majority of participants (112 or 56 percent) were HVCC students with 8 a.m. classes while HVCC faculty and staff comprised only 4 percent (9) of them. Tech Park employees were 38 percent (76) of the participants. The remaining 4 participants (2 percent) were not among the main cohorts.

All participants were selected based on an online survey (using the Zoomerang website) and underwent uniform training by RPI researchers. Once selected, both a pre- and post-survey (again online) were conducted to collect the thoughts and driving perceptions of the participants.

System Selection

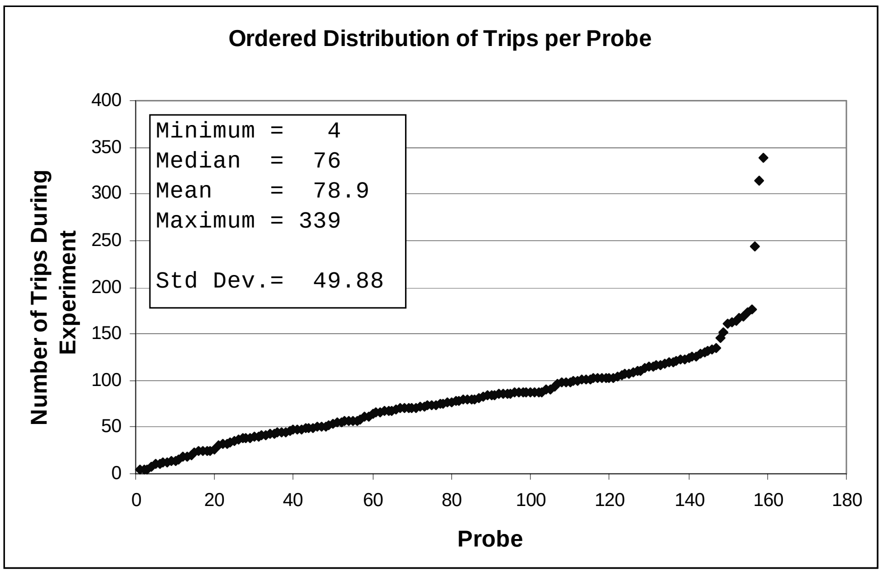
In concert with participant selection, the in-vehicle system was chosen based on researching current two-way communication technologies and in-vehicle navigation systems (onboard vs. portable), much had changed in available technology since *ADVANCE* where radio frequency communication protocol and dead-reckoning were part of the tools(Argonne National Laboratory 1997; De Leuw 1997). The chosen system for CD-ATIS was comprised of four portable components: a Pocket PC loaded with RPI CoPilot Live, an SD card to hold the map and trip data, a GPS receiver to locate the probe vehicle, and a wireless communication card. With these items, any car could easily be turned into a probe. ALK Technologies, Inc. partnered with the team to develop a beta version of their CoPilot navigation software that could support two-way communication and travel time estimation with real-time data collected from the probes. Communication was supported with a 3G card from Sprint that supported data transmission between the probes and a central server.

SAMPLE RESULTS

Available Data:

1. Link information a. Traffic characteristics b. Probe densities 2. Trip information a. OD pairs b. Paths c. Destination descriptions 3. Vehicle information a. Day-to-day patterns	4. Macro Level Information a. OD Matrices b. Traffic volumes c. Average probe speeds, densities d. Link usage 5. Micro Level Information a. Cohort travel patterns b. Individual user statistics

These represent a total of 12,629 trips incurring 147,316 miles of travel over a duration of 3,945.8 hours.



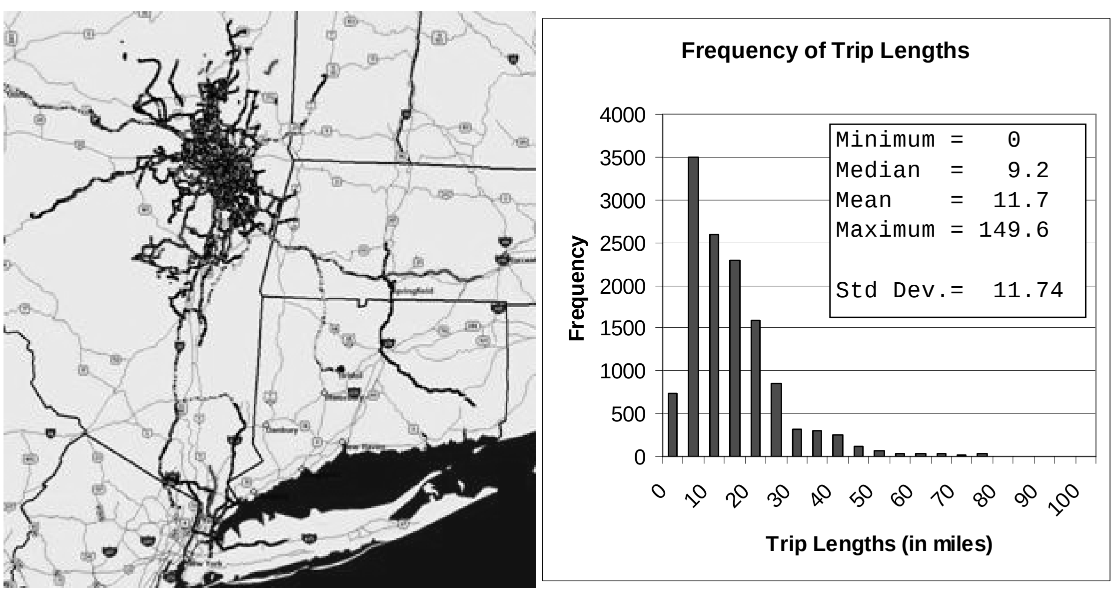


Figure 2 Map Showing Trip Routes & Graph of Associated Trip Lengths (GPS data)

Majority of trips are quite short.

experiment resulted in a total of 4,111,210 latitude-longitude and position-speed-date-time points. The largest number of location points per user was 98,018 while the smallest was 117 points. The average per user was just over 26,000 location points, or 325.5 points per trip. In terms of probe trips, there were 12,629 trips for a traveled distance of 147,316 miles over a duration of 3,945.8 hours. Average travel time was 0.312 hrs, Average distance traveled was 11.7 miles, Average speed was 32.3 mph

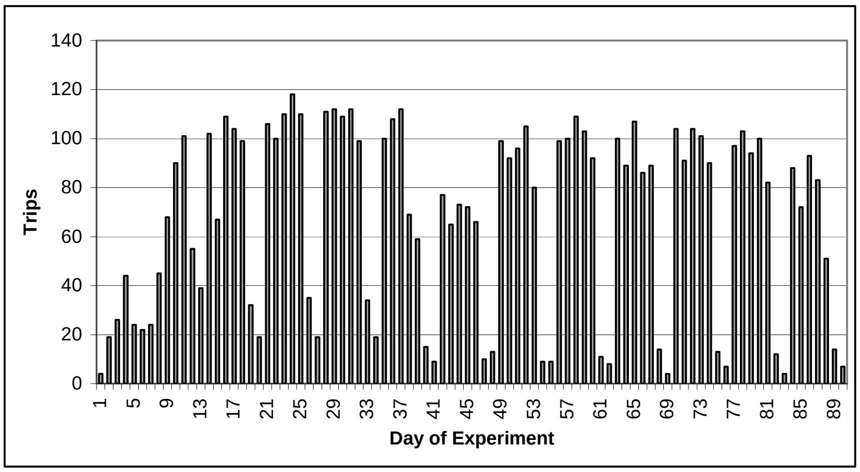


Figure 3 Number of Trips per Day

Shows the repetitive nature of trips over time from week to week

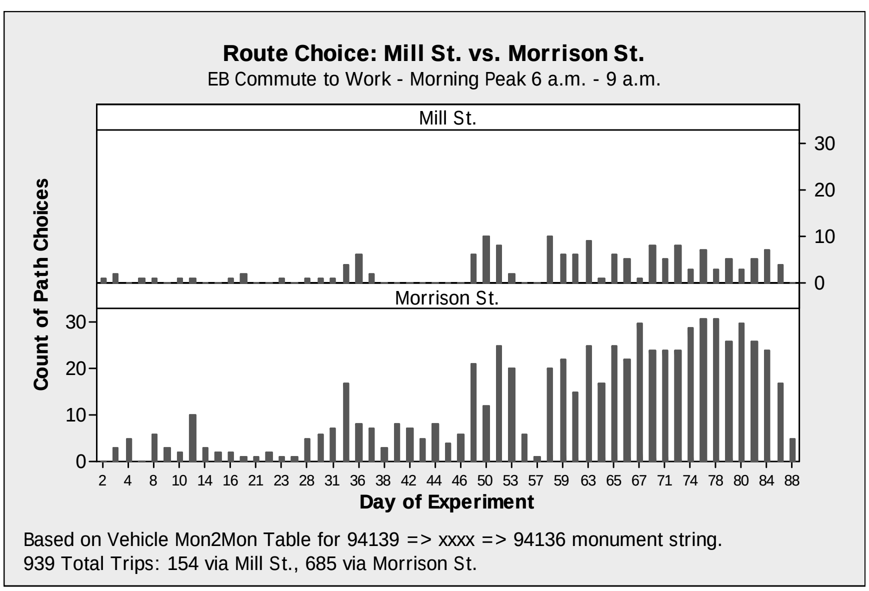


Figure 4 Probe Traffic on Two Parallel Routes

shows Mill St & Morrison St and how Morrison is the favored route most days
days like 36, 50, ~61, ~69 – 74 seem to have a higher traffic volumes on Mill and less on Morrison (possibly confirming the rerouting is working)

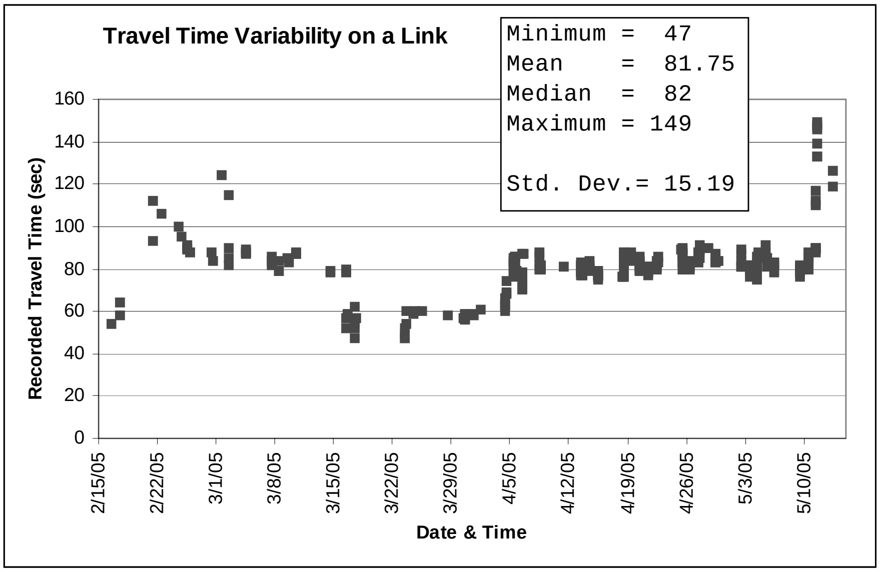


Figure 5 Travel Time Variability on a Sample Link (server data, table MMH)

Shows that the travel times on a link vary from day-to-day and at different times.

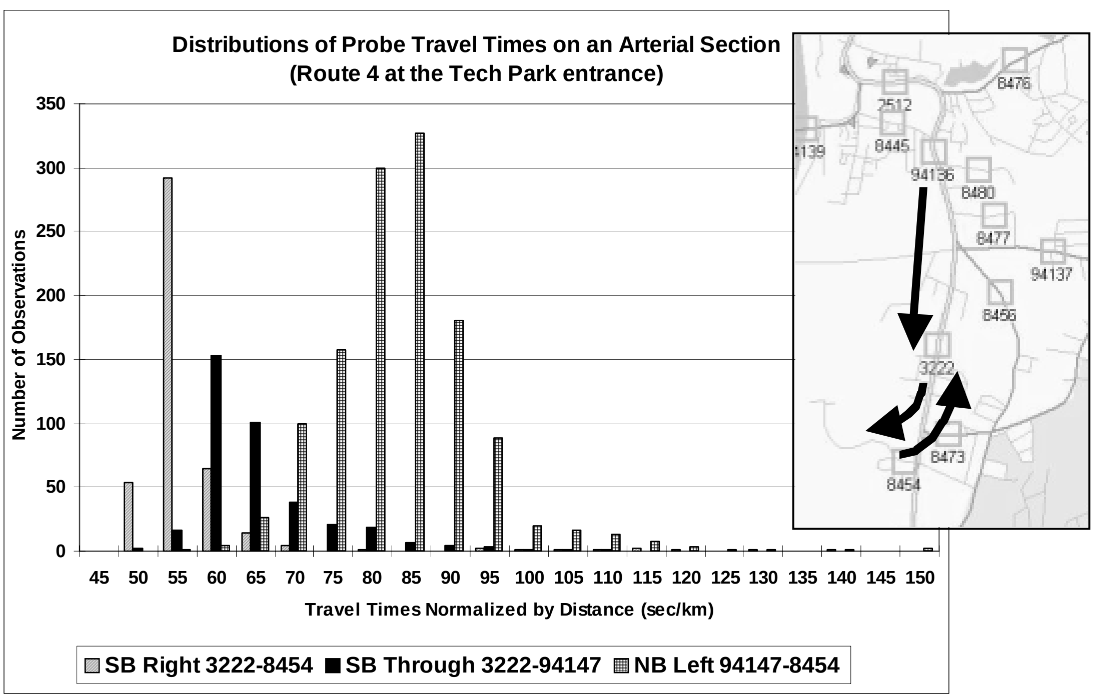


Figure 6 Travel Time Intensities along the Route 4 Arterial

travel time intensities of left, thru, right movements all shown on one graph with a small map showing the associated location & movements.

FUTURE RESEARCH DIRECTIONS

The area of advanced traveler information systems is undergoing rapid growth, of which this field experiment was one step along the avenue of probe research. Based on our experiment, members of the team plan to explore this avenue further in the areas of: route guidance software usage levels and penetration rates, user compliance, path development, trip and link speeds and travel times, and estimated time of arrival forecasting. We hope this experiment inspires others to push their ATIS and ATMS research to extend the edges of ITS knowledge.

ACKNOWLEDGEMENT

The authors wish to thank all the research partners involved - ALK Technologies, Inc. (especially Alain Kornhauser); Cornell University; Polytechnic University; CUBRC; and Annese & Associates - for helping to make the project happen. Special thanks go to NYSDOT and the USDOT for providing the funding that turned the team's ideas into reality. More thanks go to former post doctoral student Mecit Cetin (now an assistant professor at the University of South Carolina) for studying probe density issues. Finally, the authors are indebted to the team of twenty undergraduates from Rensselaer that manned the experiment every weekday starting in the wee hours of the morning.

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