IDEA

Innovations Deserving
Exploratory Analysis Programs

Transit IDEA Program

A Context Aware Transit Navigator

Final Report for
Transit IDEA Project 65

Prepared by:
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March 2013

TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

Innovations Deserving Exploratory Analysis (IDEA) Programs Managed by the Transportation Research Board

This IDEA project was funded by the Transit IDEA Program.

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- NCHRP IDEA Program, which focuses on advances in the design, construction, and maintenance of highway systems, is funded by American Association of State Highway and Transportation Officials (AASHTO) as part of the National Cooperative Highway Research Program (NCHRP).
- Safety IDEA Program, which focuses on innovative approaches for improving railroad safety and performance. The Safety IDEA program is funded by the Federal Railroad Administration (FRA).
- The Transit IDEA Program, which supports development and testing of innovative concepts and methods for advancing transit practice, is funded by the Federal Transit Administration (FTA) as part of the Transit Cooperative Research Program (TCRP).

Management of the three IDEA programs is coordinated to promote the development and testing of innovative concepts, methods, and technologies.

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Washington, DC 20001

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EXECUTIVE SUMMARY

The objective of this project was to create a real-time, context-aware transit navigation system. The system integrates the route-planning and real-time tracking functionality provided by current systems into a single, real-time and context-aware application, combining a smartphone end-user device, such as the Apple iPhone, with a sophisticated back-end service.

The completed navigation system supports unified real-time transit navigation, including walking, biking or handicapped access, across all three Chicago transit agencies: CTA buses and subway trains, Pace suburban buses, and Metra commuter rail. The back-end is built as a generic routing service, which can be used by any number of client applications. On the client side, an iPhone application has been created, with an attractive user interface and a wide selection of convenient features. The iPhone application has been published on the iTunes App store for public download. The app is downloaded by approx. 2,000–3,000 users per month, and has received over 1,000 reviews, many of which are very positive.

FINAL REPORT

2.1 IDEA Product

The objective of this project was to create a real-time transit navigation system. The system integrates the route- planning and real-time tracking functionality provided by current systems into a single, real-time and context- aware application, combining a smartphone end-user device, such as the Apple iPhone, with a sophisticated back-end service.

2.2 Concept and Innovation

In recent years, many transit agencies have added online route planners to their websites. A route planner typically lets transit riders specify points of departure and arrival, and automatically computes the best route, based on published transit schedules. Some transit agencies also provide a separate real-time tracking capability. This type of system typically lets users monitor the locations of selected buses and/or trains. Some systems can also notify users via cell phone text messaging when a bus is about to arrive at a pre-configured stop.

The novelty of our proposed system is the use of real-time information in trip planning. Whereas current systems are able to compute trip plans, these are based on transit schedules, rather than the current location and predicted arrival time of the transit vehicle. By integrating real-time information into the planning process, our system can produce faster and more reliable routes for its users.

2.3 Investigation

2.3.1 Stage 1

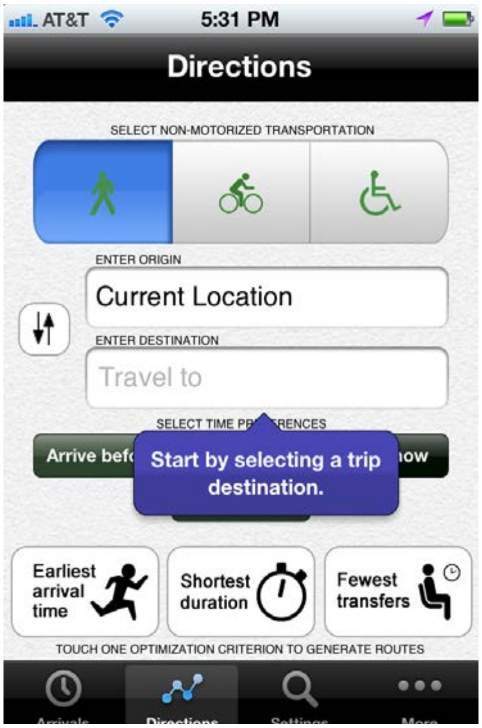
Stage 1 of the project focused on creating a functional transit navigator based primarily on publicly available data. The CTA made real-time train arrival predictions available, which we integrated. To improve efficiency, the client is performing part of the route computation, integrating real-time arrivals. This avoids the need for frequent route updates from the server, improving scalability.

Task 1 On the client side, Stage 1 included the development of an initial graphical user interface, including all the basic functionality. The client software was designed in a modular fashion that supports plug-ins for additional functionality, such as ride-sharing, integration with taxi services etc. either through the tab bar on the bottom, or through listing these alternatives as routes along with the transit routes.

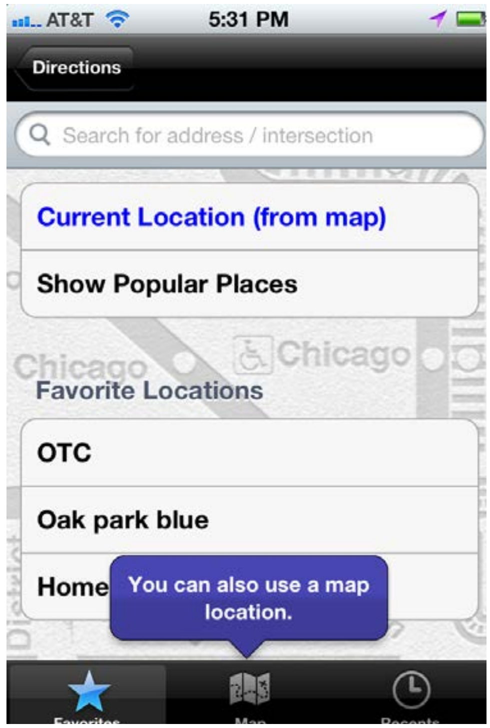
Task 2 On the server side, route optimization supports trips using heterogeneous transportation modes, using schedule-based data, depending on availability. Where real-time data is available, generated routes are reconciled with real-time updates on the client side, producing a set of real-time consistent routes.

2.3.2 Stage 2

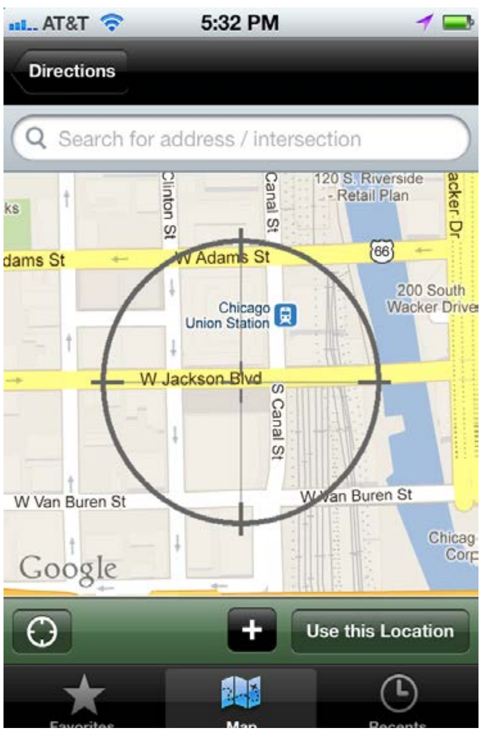
In Stage 2, the focus was on acquiring and integrating transit tracking information from all three local transit agencies. With the release of an online arrival-time prediction service by Metra on June 28, this finally became feasible as all three transit agencies are now reporting real-time tracking data. Our system is now producing routes using real-time tracking for all three transit agencies, based on data reported either through official online



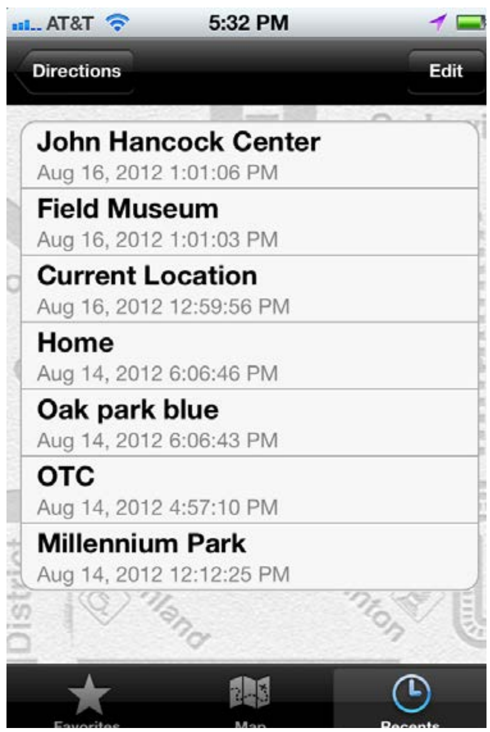
(a) Origin/Destination Selection



(b) Route Map with Bus Locations



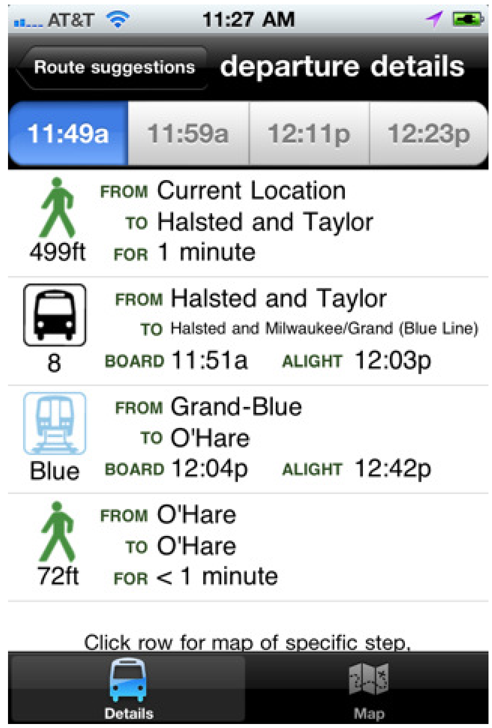
(c) Select Destination from Map or Address



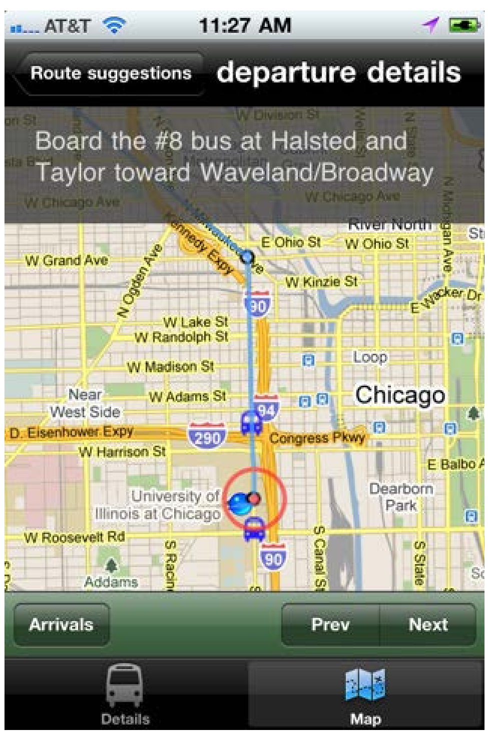
(d) Select Destination from Recent Trips

FIGURE 1: Screenshots from initial route configuration. The user can choose their origin and destination based on stored favorites, using the crosshairs on the map screen to indicate a location visually, or by selecting a recently visited location.

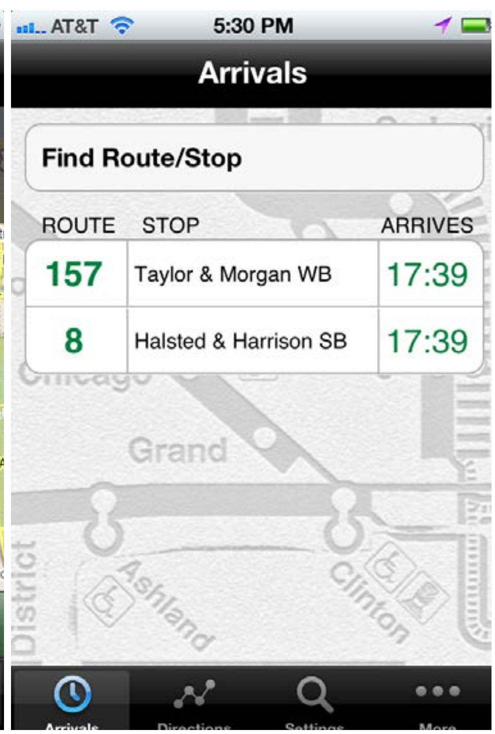
(a) Generated Route Suggestions



(b) Details of Generated Route



(c) Route Map with Bus Locations



(d) Direct Arrival Time Readings

FIGURE 2: Screenshots from directions and arrival time functionality. The user is presented with several route alternatives (a) based on real-time data from the three transit agencies. By touching the ’arrivals’ button in (c), the bus stop in question is stored on the fixed arrival times screen for quick reference.

application programming interfaces (this preferable method is supported by the CTA only), screen scraping of web pages (in the case of Pace), or through reverse-engineering of the proprietary protocols used in the public dissemination of tracking information (in the case of Metra).

Task 3 In addition to the crucial data integration described above, significant effort was put into polishing the user interface to provide an attractive and intuitive user experience. Figures 1 and 2 illustrate a subset of the functionality now offered by our transit navigation system. In Figure 1, the two 'speech bubbles' are helpful hints that show up occasionally to guide the novice user.

In Figure 2 (a), note the fact that a single origin/destination pair produced several route alternatives using five trip modalities: walking, riding CTA and Pace buses, riding CTA trains, and riding Metra trains. In this screen, the presence of real-time data is indicated by an intensely colored icon, whereas the absence is indicated by a faded icon. Here, the green line subway, in the third route recommendation is faded out, as no real-time arrival time data was available for that particular run at this time.

Finally, in Figure 2(d), we see the quick-reference arrival times screen. Frequent commuters are sometimes set on a particular route, and prefer to simply look up when the bus or train is due to arrive. Our navigation software supports this as an added convenience, and integrates directions and arrival time lookups, allowing users to quickly remember favorite routes.

Activity detection was initially included, but user testing revealed that this was an undesirable feature. Users, perhaps understandably, expected their interface to remain unchanged as they transition from being stationary to walking and were confused by the activity-based user interface components.

Task 4 On the server side, improvements are primarily to performance. The routing server now supports continuous batch queries, for rapidly producing multiple route alternatives. This is supported through a standards-based HTTP interface, which is also used by a number of student projects at UIC.

Task 5 For the Chicago metropolitan area, which we use as a proof-of-concept region, our real-time transit navigation service was provided for free to the public as a smartphone application. On a typical day, 100 new users install the software, and between 500-1,000 users request transit directions from our routing back-end. The app has received an average score of 3 stars out of 5, with many enthusiastic written reviews. The chief complaints are related to user expectations — some negative reviewers download TransitGenie expecting a simple arrival time prediction client, and are confused when they find a routing service.

FUTURE WORK

While the services have received an enthusiastic response locally, this project is at an end. Our chief concern presently is one of sustainability—a successful transit navigation service requires constant maintenance, occasional interaction with transit agencies and their online services, local server resources and at some point expansion to future cities.

A revenue source must be identified in order to guarantee the continued existence and spread of TransitGenie and similar services. Advertisement has been considered, but the potential revenue from this appears insufficient under current circumstances. Another possibility is to fund operations through referral fees from taxis and ride-share services. The feasibility of this revenue source remains to be proven. Finally, transit agencies themselves may be interested in funding the operation of the system, but in casual discussion with local transit agency officials, this does not appear to be a priority at this point.

Thus, more work remains to develop a solid business-plan for real-time transit navigation support. Once such a business-plan has been developed, we plan to submit an SBIR proposal for the commercialization of our work.

CONCLUSIONS AND SOURCE CODE AVAILABILITY

A real-time transit navigation support system has been developed that integrates routing and arrival time prediction information from multiple transit agencies in the Chicago land area. A client application was published on the iTunes App store, which received a strong reception. The next immediate step is to identify a feasible business-plan for the continued funding and commercialization of the service.

The server back-end part of the work is and will continue to be available for open-source download at `https://github.com/jeriksson/graphserver`. Depending on how future commercialization efforts develop, the client side app may also be released under an open-source license in coming years.

INVESTIGATOR PROFILE

Jakob Eriksson is an assistant professor at the University of Illinois at Chicago. He received his Ph.D. from the University of California, Riverside in 2006. After that, he spent two years as a post-doc at MIT before joining UIC in 2009.

Dr. Eriksson's research is focused on networked computer systems at the intersection of computer science and transportation, with a strong emphasis on experimental research. His work is published in top-tier conferences on sensor networks and mobile computing, such as SenSys, MobiCom and MobiSys, as well as the Transportation Research Board's annual conference, and has received awards such as Best Paper, Best Demo and Best Presentation on various occasions.

After joining UIC in 2009, Dr. Eriksson has been working with the city of Chicago as well as local transit agencies to learn about, and help improve, local public and private transportation.