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# Sustainable Technology for Person-Centered Accessible Integrated Multimodal Information Systems

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# WEB 2.0 AND WHERE 2.0 ON CAPE COD (U.S.): SUSTAINABLE TECHNOLOGY FOR PERSON-CENTERED MULTI-MODAL INFORMATION SYSTEMS.

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## SUMMARY

This paper reports on a mobility management technology project conducted by the GeoGraphics Laboratory at Bridgewater State University in Bridgewater, Massachusetts, in the Northeastern United States (U.S.). This study is a part of a much larger mobility management technology deployment by the Cape Cod Regional Transit Authority (CCRTA) that deployed integrated intermodal intelligent transportation system (ITS) to support the mobility of a metropolitan region that has a high proportion of elderly residents and persons with disabilities and is a significant tourist destination for national and international travelers. This paper reports on a research project that is developing smartphone applications to provide travelers using transit with navigational tools and real-time spatial information to optimize their travel experience. The smart phone applications are written using the Android 2.2, Windows 7.5, and Apple iOS 4 operating systems. The applications provide the traveler with schedules for every CCRTA regional and shuttle route, estimated time of arrival (ETA), and bus tracking maps (Google and Bing Maps) that locate the transit vehicle and the consumer on the same map as well as text based vehicle tracking. There is an on-line tutorial on how to use the smartphone application. It also provides features that will provide emergency communication with care givers on the consumer's travel status. The research has developed these transit navigation tools on the three most popular operating systems for smart phones using a widely available cellular carrier. An associated regional capital infrastructure project is bringing state-of-the-art broadband capability and the potential for 4G wireless infrastructure to the most rural "last mile" areas of the Cape Cod Region. These improvements to wireless communications can provide significant benefits to the safety and security of travelers with disabilities.

**Key Words:** Smartphones, automatic vehicle location, enroute trip planning, emergency assistance, intermodal integration

## PURPOSE OF THE STUDY

This paper will present the status of the development of a traveler information system using the most common smartphone platforms in the United States. The paper will describe the larger context of this research project - a large deployment of advanced public transportation systems and advanced communications infrastructure to a region that contains a significant metropolitan area but also a low-density rural area that is an international tourist destination. The paper will provide a status report on the development of the smartphone applications including: the technological context for this research project, the approach to the design and development of the software applications, results to date and anticipated results, a discussion of the preliminary findings of the project and potential for further development, a concluding statement.

## METHODS

The methodology employed to develop this smart phone application was as follows:

- Organize the research and development process, including developing and executing cooperative agreements between the Cape Cod Commission, the Cape Cod Regional Transit Authority, and Bridgewater State University's GeoGraphics Laboratory.
- Creating a project scope of work and budget for the mobility management technology project.
- Staffing the project with graduate and undergraduate students at the GeoGraphics laboratory.
- Conducting a state-of-the-art technology review.
- Assessing customer information requirements of the consumer.
- Developing 4G smart phone and wireless tablet applications for real-time traveler information for clients and caregivers.

## RESULTS OR EXPECTED RESULTS

The results or expected results of the study are as follows:

- A smart phone application on the most popular operating systems that can act as a hand-held electronic kiosk (CCRTA e-kiosk) to provide essential and timely information on the Cape Cod regional transit routes and local transit shuttle services. (See Figure 1.)
- A smart phone application that can be downloaded by the consumer from the region's transit information sites at no cost to the consumer.
- The smart phone traveler information applications will operate on the latest 4G cellular smart phone and wireless tablets in anticipation of 4G and high-end outdoor WiFi wireless area networks.
- The applications will access the region's latest general transit feed specification (GTFS) on bus stops and schedules from the CCRTA and GeoGraphics Laboratory to provide the next scheduled bus and the next bus after that on a easy to understand display.
- The applications will access the latest automatic vehicle location (AVL) of the CCRTA regional and local transit services from the GeoGraphics Laboratory's

Web mapping service and map the inbound and outbound buses on a Google map (Android 2.2 and iOS 4) and Bing map (Windows 7.5).

- The applications will access the estimated time of arrival (ETA) predictions from the CCRTA's computer assisted scheduling and dispatching (CASD) software.
- The smart phone application will display the location of the consumer ("where am I?") on a Google or Bing map showing the location of the approaching or departing bus (where is my bus?").
- The smart phone application will provide emergency communication with a designated caregiver if the consumer needs assistance.
- The smartphone will have a tutorial available in the smart phone memory to assist the traveler in using the travel information features.

## DISCUSSION

This application was built for the Android 2.2, Windows 7.5, and iOS 4 operating systems. As each of these operating systems is based on a distinctive platform, the application was developed using three different languages: Java for Android, C# for Windows and Objective-C for iOS. The features provided by this application are explained below:

- The user can view the current schedules for CCRTA bus stops. This information is stored locally on the mobile device using a sqlite database created for this application. The database is checked for updates every time the application is opened and re-downloaded when necessary.
- CCRTA vehicle locations can be viewed by the user on either a Google or Bing map based on the mobile platform. Vehicle locations are retrieved using a web service hosted on the GeoGraphics Laboratory's server. Additionally, a user can view his location in relation to nearby stops and buses.
- Estimated Time of Arrival (ETA) information allows a user to track the arrival time of a bus for a CCRTA bus stop. ETA information is transmitted to the application using the same web service utilized by the vehicle tracking.
- The user can view bus locations in a text format, such as the real-time street locations of CCRTA buses. This data is fetched from the same web service which provides information for the two previous features. With the use of a screen reader, this feature will allow users with low vision to track vehicle locations.
- In the case that a user needs assistance, he has the option to make an emergency call to a caregiver. Emergency contact information can be set by the caregiver in the application settings. Once this

information is set, the user need only click on the emergency call button on the main menu to automatically call the caregiver.

## FINDINGS

- Smartphones are powerful transit navigation tools that are readily available for residents and visitors to Cape Cod.
- Smartphones need at least 3G communication speeds and work best at 4G (not currently available on Cape Cod).
- Despite accessibility features in smartphones, such as text-to-speech and expanded print capabilities, these smart phone applications are less effective for the visually impaired than purpose-built devices in the marketplace for persons with low vision. Previous work by the GeoGraphics laboratory that converted the global positioning systems (GPS) data from bus locations into the street address, nearest intersection, bearing and speed that can be provided as a text table and converted to speech was found to be more useful for individuals who had very low vision or were blind. (See CCRTA PDA display at www.geolabvirtualmaps.com .)
- These smartphone applications may be useful for the intellectually impaired consumer or for consumers experiencing memory loss or confusion associated with accidents or aging. After beta testing these three operating systems on the Sprint cellular network, the next step in this development process is to recruit individuals and organizations from the Cape Cod Region to test these navigation tools in daily life.
- With the potential for wireless capabilities from WiMAX or outdoor high-capacity WiFi emerging from Open Cape Broadband, issues associated with cellular wireless (e.g. speed and cost) may be overcome in typically underserved areas (e.g. rural and poor communities) using publicly-owned wireless metropolitan area network (WMAN) for “last mile” wireless communication for assisting persons with disabilities using both fixed route and paratransit services.

## CONCLUSION

While the Cape Cod Regional Transit Authority was an early adopter of advanced public transportation systems technology, these technologies are increasingly being deployed on a world wide scale. In particular, automatic vehicle location systems and Web-mapping of real-time vehicle location for local, regional and inter-regional passenger transportation systems is increasingly available. These Web 2.0 and Where 2.0 systems are the basis for creating real-time smart phone applications that can be helpful for individuals that find the fixed route transit services difficult to navigate the main stream intermodal passenger systems. As smart phones increase in computing capability at reasonable mass market prices, these tools can be adapted for individual needs to provide a universal tool for a variety of consumers using public transportation systems, particularly individuals with intellectual

disabilities, people dealing with memory loss associated with aging or accidents, and tourist attempting to access recreation facilities without an automobile.

The potential improvements to non-commercial public services communications systems provided by the development of the Open Cape Broadband "middle mile" fiber optic network and "last mile" wireless metropolitan area networks (WMAN) may also dramatically lower the operating cost of these smartphone intermodal navigation tools by using the free WiFi communications for the application, rather than the commercial cellular network. If free outdoor WiFi is available at every bus shelter, on every bus and at every major transit destination, the cost of using the CCRTA e-kiosk smartphone application for persons with disabilities and other residents and tourists will be very low.

While this paper focuses on a smart phone navigation tool that integrates the CCRTA's regional and local fixed route services, inter-regional passenger transportation systems can also be integrated using this tool. The Cape Cod Mobility Management Technology Project also developed web mapping applications for the inter-city bus services from New York City (NY, USA) and Boston (MA, USA) to Cape Cod and for the passenger ferry services from Cape Cod to the offshore islands of Nantucket and Martha's Vineyard and from Boston and Plymouth (MA) to Cape Cod. (See intercity bus and ferry Web AVL at www.geolabvirtualmaps.com.) While adding these inter-regional services to the smartphone navigation tool, CCRTA e-kiosk, is not a trivial matter and requires public-private cooperation, it certainly is feasible. This provides an enroute transit planning tool that is cognizant of the environmentally sensitive nature of recreational travel to a region dependent on the tourist economy by providing a means for car free access to Cape Cod.

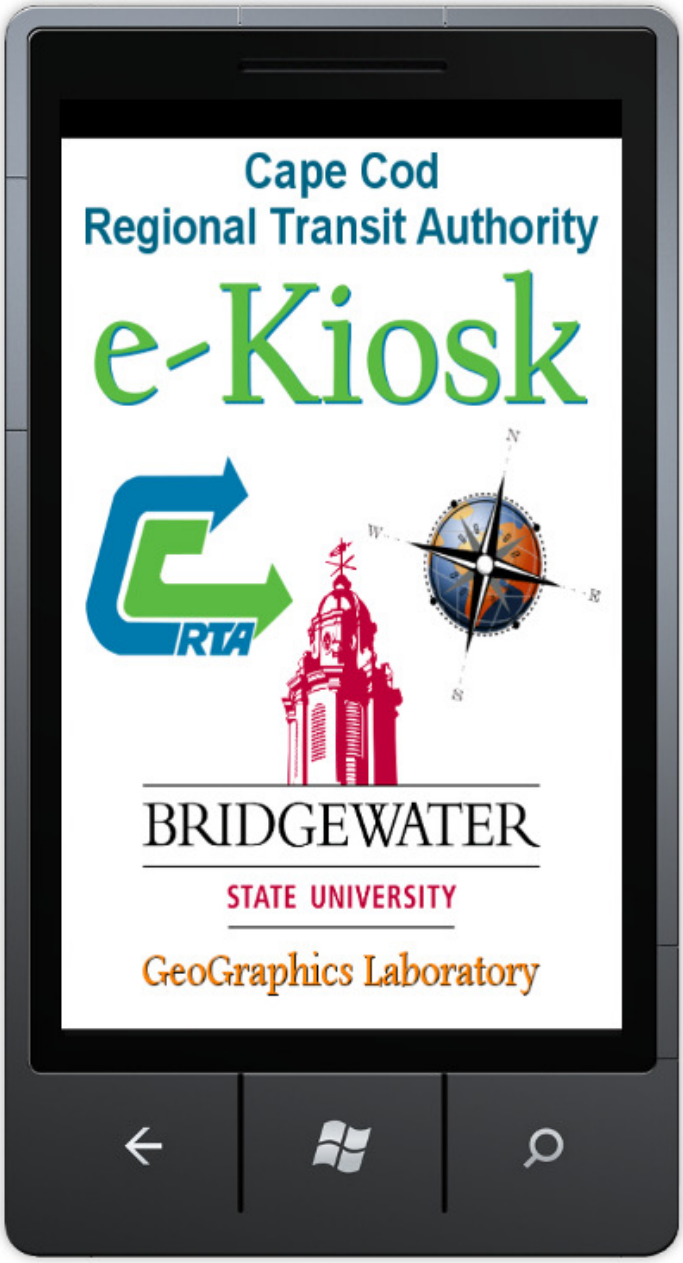


**Figure 1. Opening Screen CCRTA e-kiosk. This figure provides the names and logos of the sponsoring agencies. The Windows 7.5 device includes a back arrow; Windows function key, and zoom tool.**

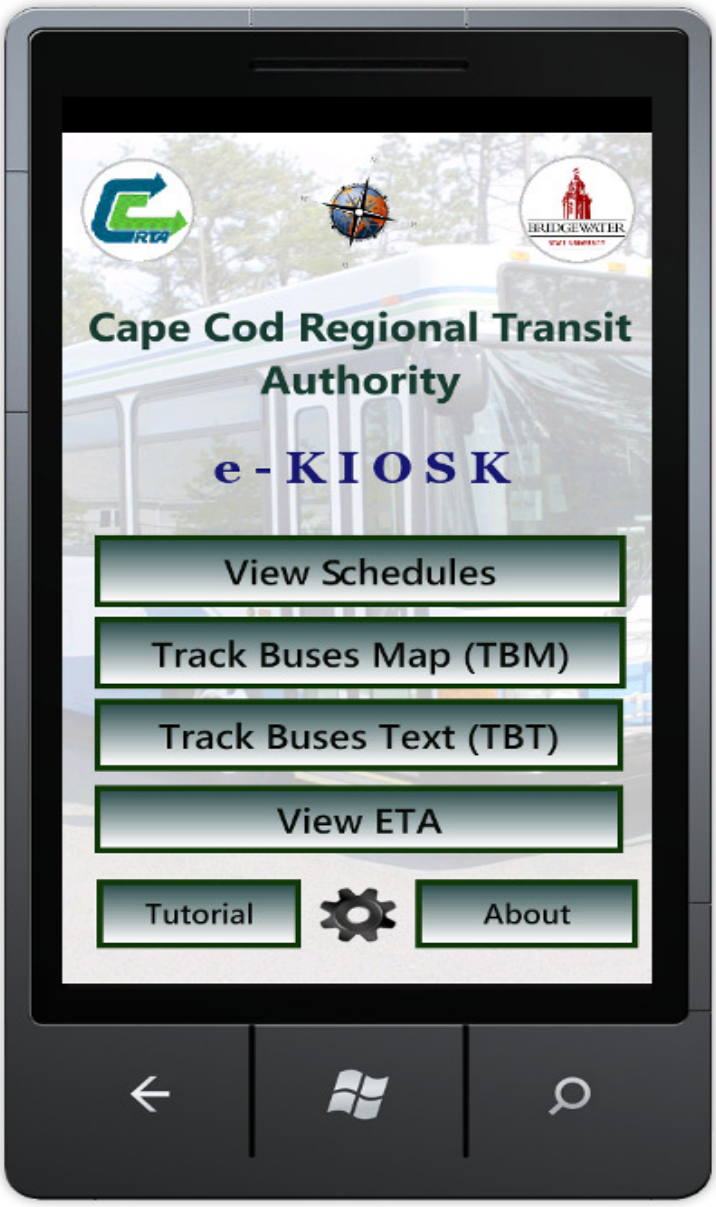


**Figure 2. Opening CCRTA's e-Kiosk provides six screen buttons: View Schedules, a Track Buses Map (TBM), a Track Buses Text (TBT), View ETA, a tutorial, a settings symbol, and an "about" button.**

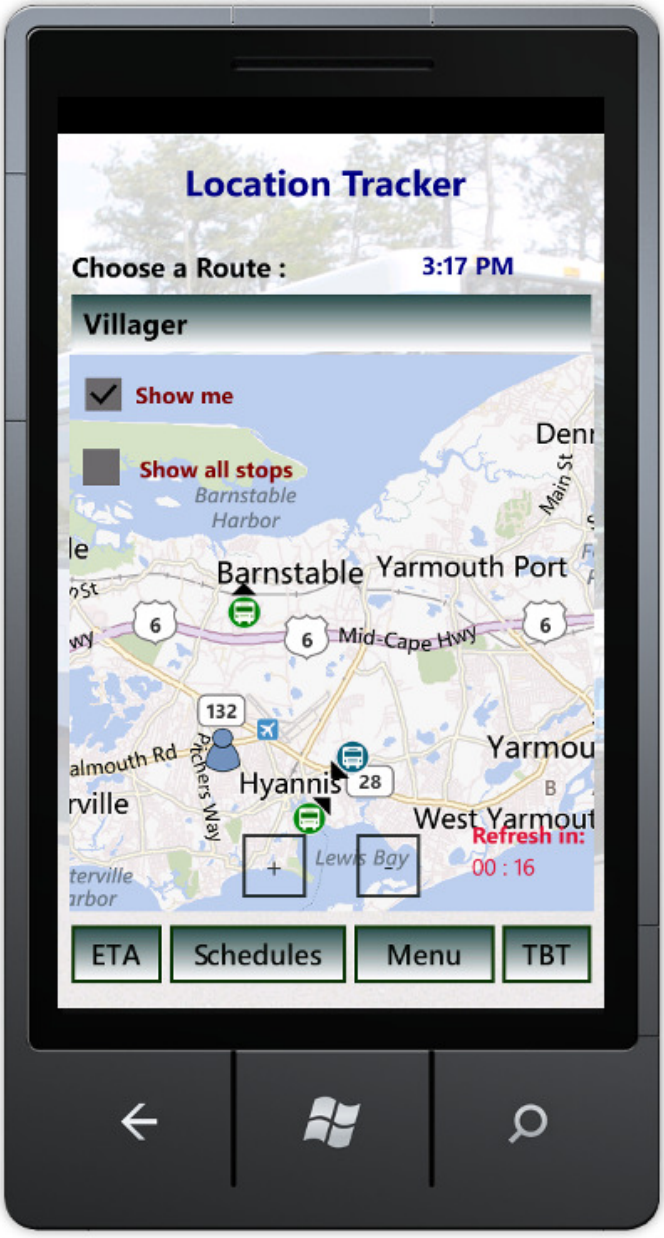


**Figure 3. Pushing the TBM button brings up a map that can show where the user is in relationship to the inbound and outbound buses on a chosen route. A + or – button adjusts map scale. There are also screen buttons for ETA, schedules, the main menu and TBT. There is a countdown for automatic refresh of the location data on the screen.**


Figure 4. A screen shot of Bus Tracker Map using the option to show the location of all stops in relation to the user, and the inbound and outbound bus icons that show their direction. The screen buttons for ETA, Schedules, Menu and TBT are also shown with zoom in or out screen buttons.