T-BEST: Nothing But the Best for All Your Transit Planning and Ridership Forecasting Needs

Have you been looking for a transit planning tool that:

- accurately forecasts transit ridership and accessibility at the individual route and stop level?
- accurately predicts changes in transit ridership due to changes in socio-economic characteristics of your area?
- allows you to precisely determine the impacts of service changes on stop-level ridership and transit performance?
- helps you test alternative route configurations to best meet the transit needs of your area?
- is interfaced with the ArcGIS package for powerful network coding, visualization, database management, and analysis capabilities?
- is completely menu-driven and very user-friendly?

If you answered YES to any one of the questions above, then T-BEST is for you. T-BEST is a stop-level *Transit Boardings Estimation and Simulation Tool* that serves as a comprehensive transit planning system. Its menu-driven structure and powerful ArcGIS interface make it the ideal tool for planning and analyzing transit systems.

Background

Over the past few years, the Public Transit Office of the Florida Department of Transportation has been spearheading the development of transit demand forecasting models and transit systems planning tools for a wide variety of applications as part of its broader Transit Model Improvement Program. Quite often, transit agencies do not have the resources and staff to implement large-scale travel demand modeling systems or collect and assemble the elaborate databases needed to support such model systems. The model development efforts of the FDOT Public Transit Office have been focused on meeting the transit planning and modeling needs of a wide variety of planning agencies through the development of user-friendly tools that can be implemented in a wide variety of planning contexts.

Examples of model systems and planning tools developed under this initiative include the Integrated Transit Demand and Supply Model (ITSUP), Regional Transit Feasibility Analysis and Simulation Tool (RTFAST), Transit Level of Service software (TLOS), and Florida Transit Information System (FTIS). Among these tools, ITSUP and RTFAST, completed in 1999 and 2002 respectively, served as early attempts at developing stop-level transit ridership forecasting models with ArcView based GIS visualization and data management capabilities. Over the past few years, the user community has shown substantial interest in using stop-level ridership forecasting models such as ITSUP and RTFAST and has provided useful feedback for the development of the next generation of stop-level ridership forecasting models.

T-BEST represents a culminating effort towards developing a truly operational and user-friendly stop-level ridership forecasting software package that offers full GIS-based functionality and network coding capability. The software not only incorporates many of the features and methodologies of its predecessors (i.e., ITSUP and RTFAST), but also includes a host of new methodological developments that make it a very powerful transit planning and analysis package. CUTR Faculty Xuehao Chu and Steve Polzin teamed up with CUTR Faculty Associate Ram Pendyala of the Department of Civil and Environmental Engineering to develop a comprehensive ridership forecasting methodology for T-BEST. Software programming services were provided by Rodney Bunner, GeoDecisions, Inc. of Tampa.

The T-BEST Methodology

T-BEST is a comprehensive transit analysis and ridership forecasting model that is capable of simulating travel demand at the individual stop-level while accounting for network connectivity, spatial and temporal accessibility, time-of-day variations, and route/stop competition and complementarity. The current version of T-BEST has been calibrated using socio-economic, transit network, and automated passenger count (APC) (ridership) data from Jacksonville. Socio-economic data used for model development were derived from the 2000 Census and InfoUSA employer databases.

In the context of T-BEST, ridership is defined as the number of boardings at a stop. T-BEST simulates distinguishes among stops at the same location, by route and direction. Thus, it is a "micro-level" model that can provide ridership estimates at a very fine level of detail. However, T-BEST can also be used to obtain more aggregate route level, segment level, location-based, or system level measures through the aggregation of stop-level outputs. By simulating ridership at the level of the individual stop, the model intends to provide a strong platform and robust framework for modeling transit ridership in a region by time of day and day of week.

The T-BEST approach to transit ridership forecasting recognizes that numerous factors affect stop-level boardings. The methodology underlying T-BEST has been developed to ensure that the final model is sensitive to a wide range of socio-economic and supply attributes. In particular, the following features of T-BEST are noteworthy:

1. *Distinction Between Direct and Transfer Boardings*: T-BEST incorporates separate equations for estimating direct boardings and transfer boardings at each stop location. At any given transit stop, one may have patrons who begin their trip at the designated stop and other patrons who are transferring to a different route at the designated stop in the middle of a trip/journey. By distinguishing between direct and transfer boardings, T-BEST is able to:
   a. provide a quantitative measure of the extent of trip linking that is occurring
   b. analyze the impacts of transfer points and transfer opportunities on ridership.

2. *Time of Day Based Analysis*: T-BEST includes separate ridership estimation equations for each time of day and day of week. The times of day that have been incorporated into the current version of T-BEST include:
   a. Weekday peak period (covering both the AM and PM peaks)
   b. Weekday off peak (midday) period
   c. Weekday night period
   d. Saturday (all day)
   e. Sunday (all day)

   Although T-BEST is able to provide time-of-day based ridership forecasts as defined above, it is not able to provide ridership estimates by trip purpose. Data limitations precluded the estimation of separate model equations for different trip purposes in the current version of T-BEST.

3. *Spatial Accessibility (Socio-economic Characteristics)*: T-BEST accounts for spatial accessibility in computing boardings at individual stops. Presumably, ridership is dependent on the number of people of various characteristics (defined by age, working status, race/ethnicity, income, car ownership, etc.) who can access the transit system. T-BEST considers circular buffer areas around individual stops to identify the market (in terms of population and employment) that has access to the transit system. T-BEST also incorporates a sophisticated methodology to split population and employment across overlapping buffers to avoid double-counting.

4. *Time-Space Network Connectivity*: In addition to considering spatial accessibility at the origin stop, one needs to consider the overall connectivity and time-space accessibility that a system provides to accurately compute ridership at any stop. People are more likely to use a transit system (stop) that is well connected and from which many destinations offering a range of activity opportunities can be reached. Also, the network connectivity and range of reachable destinations may be different at different times of the day due to supply differences by time of day. T-BEST incorporates a comprehensive and sophisticated methodology for computing spatio-temporal transit accessibility

accounting for time-space network connectivity, thus making it the ideal tool for transit planning and ridership forecasting.

5. *Competing and Complementary System Effects*: Within a transit system, there are bound to be competing and complementary system effects that affect ridership. For example, any stop is likely to have several neighboring stops that are competing for the same market/riders. Similarly, there may also be complementary effects that affect and enhance ridership at a stop. For example, if a stop is a transfer point where two or more routes meet, then the number of boardings at the stop may be enhanced by virtue of the transfer opportunities present there. T-BEST explicitly accounts for both of these effects in computing stop-level ridership.

6. *GIS-Based Software Tool*: T-BEST has been developed so that the user can interface with the software largely through an interface that provides full GIS functionality. A user needs to have ArcView 8.3 or later residing locally on the machine to use T-BEST. A modest investment in ArcView 8.3 will allow the user to untap the full potential of T-BEST. Socio-economic scenarios, supply attributes, and route and stop configurations can be changed and edited on the fly, thus making T-BEST a truly user-friendly transit ridership forecasting tool.

7. *Performance Measures*: T-BEST includes estimates of several performance measures in its output. Performance measures such as route miles, service miles, service hours, boardings per service mile or hour, and average boardings per service run are provided by T-BEST at the individual route-level and for the system as a whole. These performance measures can be used to assess the impacts of various socio-economic and supply scenarios on system performance.

8. *Sensitivity to a Host of Planning Factors*: Ridership estimates provided by T-BEST are sensitive to a host of planning factors including socio-economic characteristics, network configuration and connectivity, and transit system attributes. T-BEST ridership estimates are sensitive to population characteristics such as income, auto ownership, household size, number of children, number of elderly, race/ethnic composition, and number of workers. Employment variables in the T-BEST equations include commercial, industrial, and service employment (consistent with definitions used in FSUTMS). Transit system attributes that affect ridership include first boarding fare, transfer fare, travel time, frequency/headway, special generator type (e.g., shopping mall, stadium, university, etc.), number of transfers, out-of-vehicle time including both access/egress time and waiting time, route type (e.g., crosstown, express, local, circulator, etc.), and technology type (e.g., BRT, bus, trolley, etc.).

The T-BEST Software

The T-BEST software is a comprehensive package that allows users to set up databases, manage databases and scenarios, execute model runs and accessibility/impedance calculations, compute boardings estimates, and view output reports in a tabular form. Users can interactively modify routes and stops, add and delete routes and stops, change route and stop attributes including socio-economic characteristics, and select subsets of stops and routes for analysis using the graphical user interface offered by T-BEST. Figure 1 shows a typical map editor interface of T-BEST. There are essentially three elements in this interface, i.e., the route window that includes a complete listing of routes and their attributes, a map window that includes full interactive mapping capability, and a stops window that includes a complete listing of selected stops and their attributes.

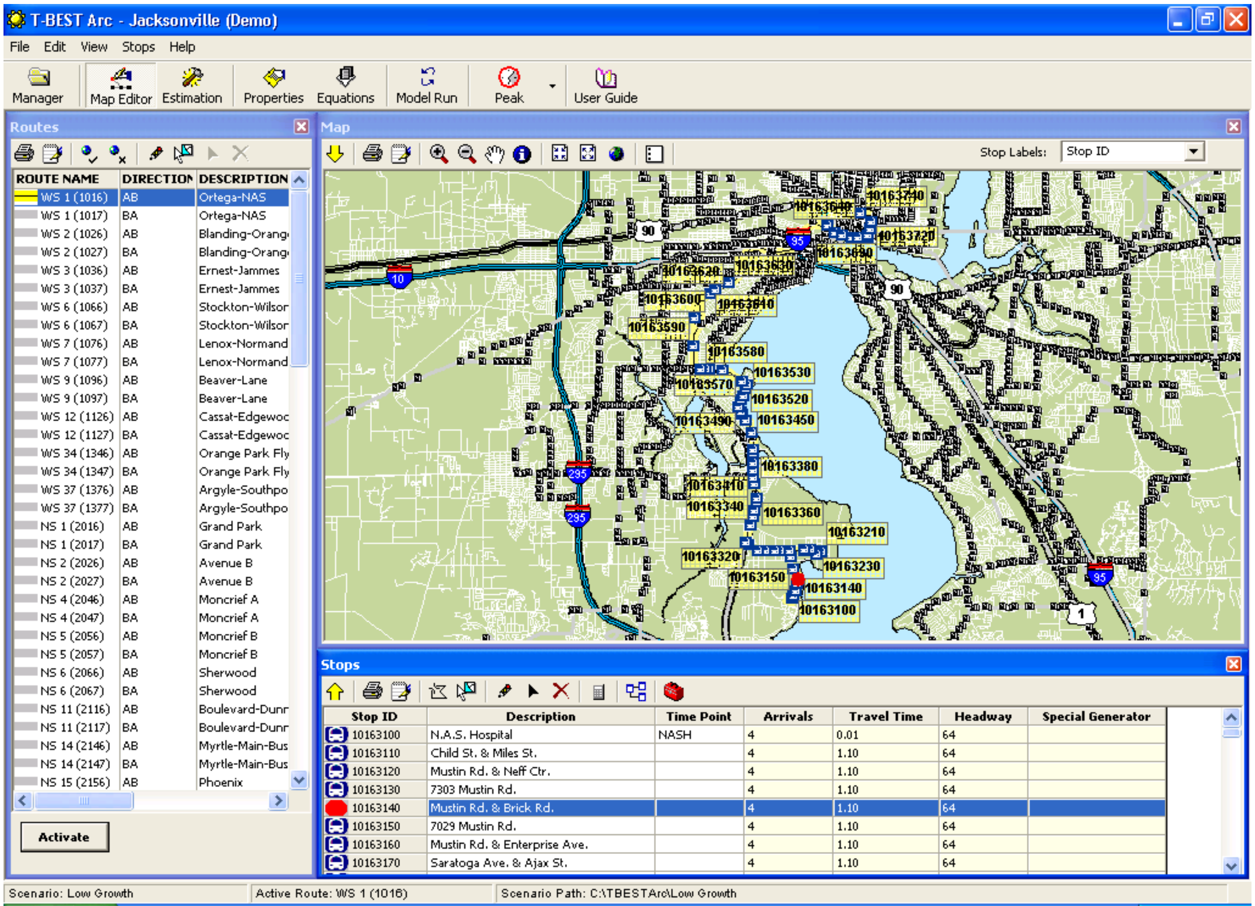

Figure 1. Sample T-BEST Screen Showing Interactive Map Editor Window

The tool bar at the top of the screen includes several buttons for executing the various functions of T-BEST. The *Manager* button allows users to manage scenarios and define system wide parameters for different scenarios. The *Map Editor* button brings up a screen similar to that shown in Figure 1 and allows users to interactively modify the scenario using the map and tables. The *Properties* button allows users to define system wide variables for the particular scenario including identification of fares, transfer hubs, and interlining routes. The *Equations* button allows users to bring up the table of model coefficients for each time period with the possibility to modify the coefficients for a particular scenario. The *Model Run* button, when activated, will execute a full run of the T-BEST model including all accessibility and impedance computations for the network. However, actual stop- or route-level boardings estimates are obtained by clicking the *Estimation* button. The pull-down menu corresponding to the button *Peak* allows users to choose an alternative time period for analysis. Finally, the *Users Guide* button brings up the entire Users Guide in a PDF document.

Figure 2 shows an example screen of stop level boardings estimation output. T-BEST provides the number of transfer opportunities, direct boardings, and transfer boardings at each stop and for each route by direction. If the output is requested at the route-level (as opposed to the individual stop-level), then a series of performance measures are reported in the output table. This is shown in Figure 3.

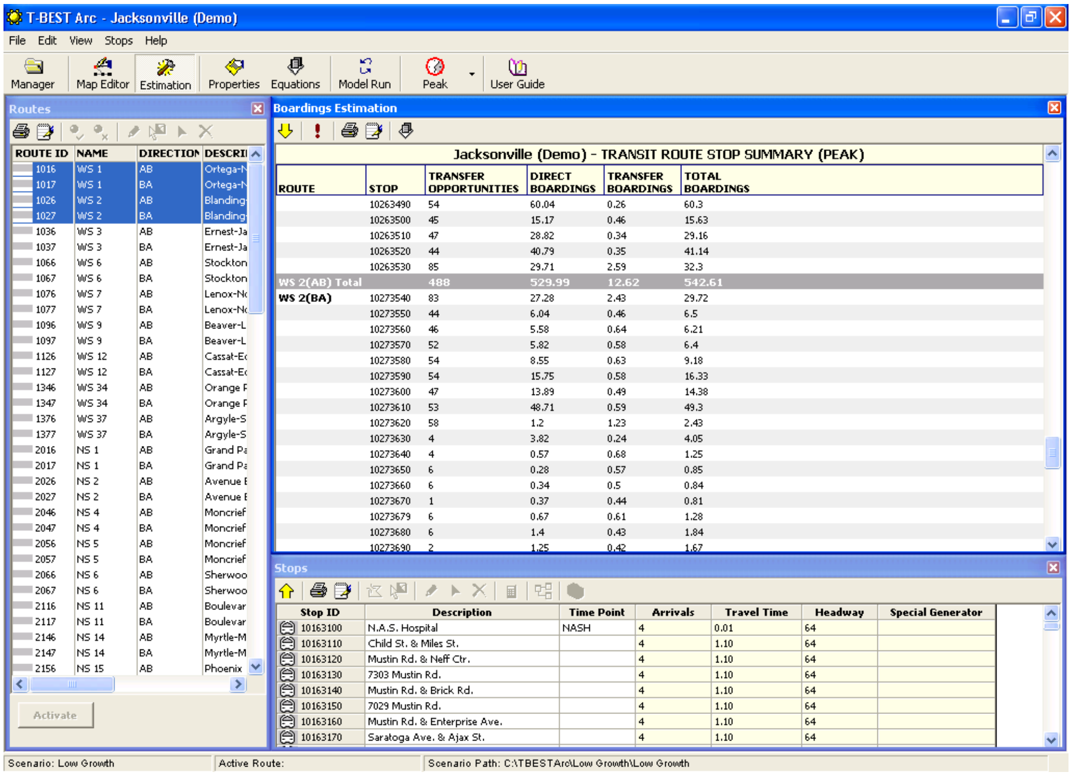

Figure 2. Stop Level Boardings Estimation Output Table

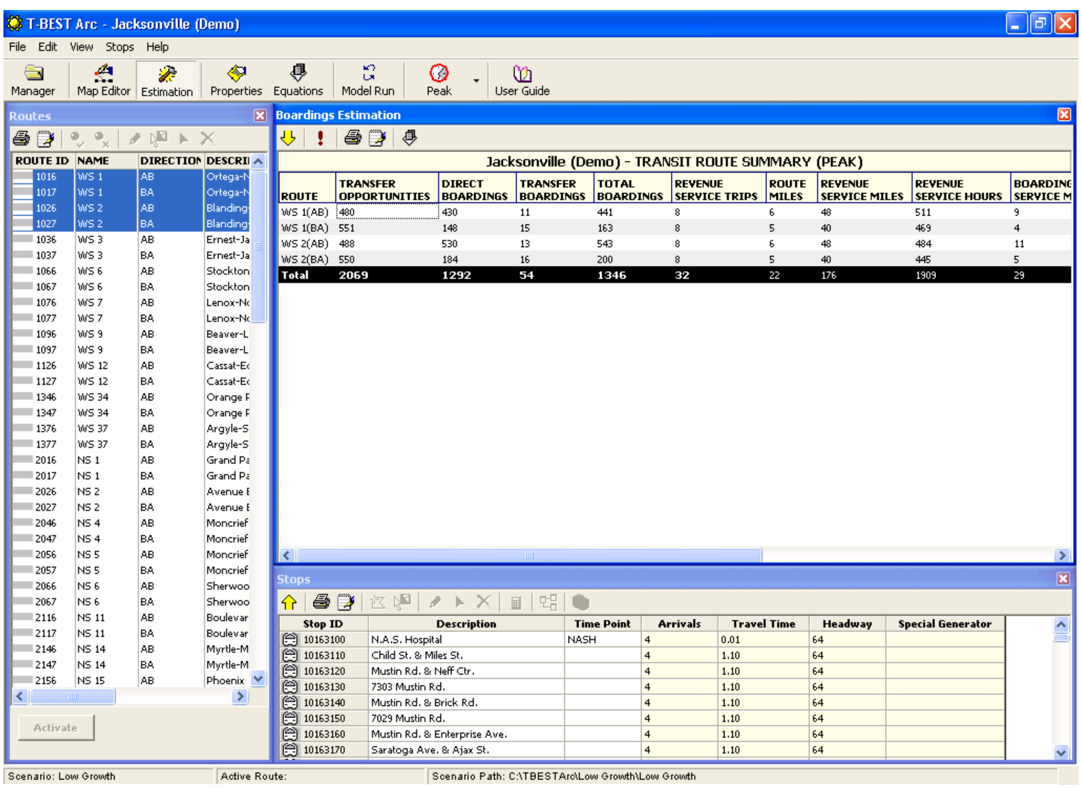

Figure 3. Route Level Boardings Estimation Output Table

Training and Software Availability

The T-BEST installation CD (or setup files downloaded from the T-BEST websites) includes census data, employment data, and highway network data for the entire State of Florida. Users only need to define and provide transit system (i.e., route and stop) data for T-BEST. The coding and definition of transit stop and route attributes can be done completely within the T-BEST map editing and database management interface, thus providing a user-friendly capability for setting up T-BEST in a local context. The T-BEST software package is free and may be obtained from Ike Ubaka, the T-BEST Project Manager at the FDOT Public Transit Office who may be reached by calling (85) 414-4532 or sending e-mail to ike.ubaka@dot.state.fl.us. The software may also be obtained from Ram Pendyala, Department of Civil and Environmental Engineering - University of South Florida, who may be reached by calling (813) 974-1084 or sending e-mail to pendyala@eng.usf.edu. The software will also be available for download within the next few weeks at both the FDOT Public Transit Office website (http://www.dot.state.fl.us/transit/default.htm) and the Center for Urban Transportation Research (CUTR), University of South Florida website (http://www.cutr.usf.edu).

Two hands-on computer-based T-BEST training workshops will be held within the next six months. The first training session is scheduled for Wednesday, December 8, 2004 from 8 AM to 5 PM in the Department of Civil and Environmental Engineering Computer Laboratory at the University of South Florida in Tampa. To register for this free workshop, please send e-mail to pendyala@eng.usf.edu with full contact information including Full Name, Job Title, Agency, Complete Mailing Address, Phone, Fax, and Email.

It is envisioned that T-BEST will be further enhanced in the near future. Users are encouraged to provide feedback and comments on how T-BEST can be further enhanced to meet transit planning needs in the state to Mr. Ike Ubaka, the T-BEST Project Manager at the FDOT Public Transit Office. Questions and requests for additional information regarding the T-BEST methodology can be addressed to CUTR Faculty Xuehao Chu at xchu@cutr.usf.edu, Steve Polzin at polzin@cutr.usf.edu, or CUTR Faculty Associate Ram Pendyala at pendyala@eng.usf.edu.