An Overview of STOPS

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The 2013 Final Rule on major capital investment projects revised the measures that FTA uses to evaluate and rate proposed major transit projects. Among the revised measures, the Final Rule specifies that mobility benefits are now measured as the predicted number of trips that would use the project, with a weight of 2.0 applied to project trips that would be made by transit dependents. The Final Rule also identifies the predicted change in automobile vehicle-miles of travel (VMT) as a component of the measure of environmental benefits of proposed projects.

In the Final Rule, FTA promised to develop a simplified method that project sponsors can use, at their option, to predict the trips-on-project measures and the automobile-VMT change needed for the environmental measure. STOPS – Simplified Trips-on-Project Software – meets that requirement. STOPS is a stand-alone software package that applies a set of travel models to predict detailed transit travel patterns for the No-build and Build scenarios, quantify the trips-on-project measure for all travelers and for transit dependents, and compute the change in automobile VMT based on the change in overall transit ridership between the two scenarios.

General Characteristics

STOPS is fundamentally a conventional "4-step" model set that considers zone-to-zone travel markets stratified by household auto-ownership, employs a conventional mode-choice model to predict zone-to-zone transit travel based on zone-to-zone travel characteristics of the transit and roadway networks, and then assigns the trips predicted to use fixed guideways onto the various rail and bus-rapid-transit facilities (including the proposed project) in the transit network. STOPS is different from the conventional 4-step model in several important ways:

1. To represent overall travel patterns, STOPS replaces the trip-generation and trip-distribution components with worker-flow tabulations from the Census Transportation Planning Package (CTPP). STOPS factors the worker flows to represent home-based work-trip patterns and to account for home-based non-work-trip patterns as well. STOPS uses the transit trip attractions predicted in each zone for home-based travel to characterize the non-home-based travel market. To enable predictions in different years, STOPS scales the resulting trip patterns to population and employment estimates provided by the user for any specific year.

2. To represent the transit system, STOPS replaces the coded transit network with data in the General Transit Feed Specification (GTFS) developed by local transit providers to support mobile and on-line transit trip-planning applications. To represent transit services different from the current system described in the GTFS data (the project, adjustments made to integrate the project into the system, services planned for future years, etc.), the user edits the GTFS data to add new services, and modify or delete current services.

3. To represent conditions on the roadway system, STOPS relies on zone-to-zone roadway times and distances derived from the regional travel model for both the current year and, if applicable, the future year. STOPS does not include any representation of the roadway network itself and does not assign predicted automobile trips to any network. STOPS computes the change in automobile person-miles of travel caused by shifts of trips from autos to transit by multiplying the predicted change in zone-to-zone transit trips by the zone-to-zone roadway travel distance.

4. To inform the component models on travel behavior with respect to transit fixed guideways, STOPS has been calibrated and validated against current ridership on 24 fixed-guideway systems

in 15 metropolitan areas in the United States. Consequently, STOPS is based on travel behaviors in a broad range of contexts – in contrast to the conventional calibration of regional travel models only for individual metropolitan areas where they are applied. When it is applied in a specific metropolitan area, STOPS makes adjustments to its basic calibration using (1) the current total number of system-wide transit boardings, (2) the share of CTPP worker flows to jobs in each subarea that is captured by transit, and (3) the daily number of boardings at individual stations on any existing fixed-guideway facilities.

The use of standardized data-sources – the CTPP worker flows and the GTFS transit descriptions – means that STOPS has consistent information across all metro areas regarding travel patterns and transit services. This consistency give STOPS a much better chance to discern actual travel behaviors that would otherwise be obscured by inconsistencies in conventions, definitions, data, quality control, and other elements of regional travel models and their maintenance. In the future, an analogous treatment of roadway conditions may become possible; at this point, however, STOPS relies on the regional model in each metro area to characterize current and future roadway conditions.

The component models in STOPS have been calibrated against rider-survey datasets from six metropolitan areas that have both fixed-guideways and survey data adequate to the task:

- Atlanta: heavy rail
- Charlotte: light rail
- Denver: light rail
- Phoenix: light rail
- San Diego: light rail(2), commuter rail
- Salt Lake City: light rail, commuter rail, bus rapid transit

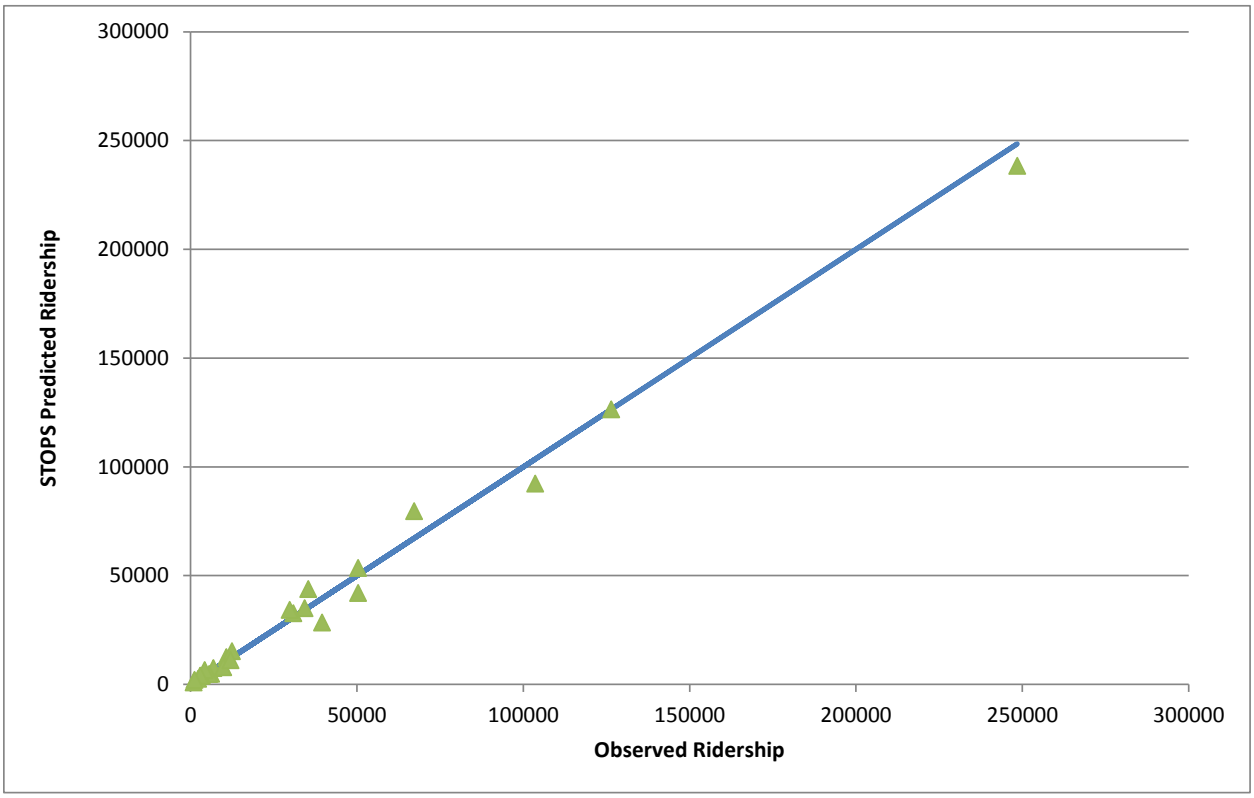

Figure: Predicted and Observed Weekday Ridership on Fixed Guideway Systems Used in STOPS Development

STOPS has also been validated against station-specific counts of trips in nine other metropolitan areas that have fixed-guideway systems:

- Kansas City: bus rapid transit
- Houston: light rail
- Minneapolis: light rail, commuter rail
- Nashville: commuter rail
- Norfolk: light rail
- Portland: light rail, commuter rail, streetcar
- San Jose: light rail
- Seattle: light rail, commuter rail, streetcar
- St. Louis: light rail

The figure summarizes the validation results, comparing the STOPS prediction to actual fixed-guideway ridership in each of the 15 metropolitan areas. The STOPS predictions are based on the underlying national calibration of the component models and the metro-area-specific adjustment with total weekday boardings on the area's transit system. The predictions do not reflect the final STOPS adjustment for each metro area that normalizes the forecasts to current station volumes. That adjustment brings all of the points onto the diagonal line representing effectively exact matches between predicted and observed volumes.

Useful Applications

The development of STOPS proceeded directly from the requirement established in the Final Rule on major capital investments: to provide a simplified method that project sponsors can use, at their option, to quantify the trips-on-project measure and the VMT change needed for the environmental measure. Consequently, its specific intended application is for New Starts and Small Starts projects.

Project sponsors may find STOPS to be a useful alternative when locally maintained methods – either the regional model or an incremental model – are unavailable. A regional travel model might be unavailable because it does not include the components needed to predict transit travel or because the model has not undergone meaningful tests against suitable data on current transit ridership. An incremental model might be unavailable because such a procedure has not been developed locally or because the proposed project is likely to serve travel markets that will largely exist only in the future and are not present in current ridership data that are the starting-point for incremental methods.

Project sponsors may also find STOPS to be useful in a quality-control role – providing a second ridership forecast for comparison to a forecast prepared with locally maintained methods. The comparisons can highlight differences in the travel markets predicted to contribute trips to the project, changes in overall transit trip-making, distributions across trips purposes, and other characteristics. Resolution of these differences often leads to a deeper understanding of the travel markets served by the project and the uncertainties that may be present in the forecasts.

Project sponsors who use STOPS to make forecasts for projects may decide to provide only those forecasts to FTA in support of project submittals, or to provide only the forecasts developed with local procedures, or to provide both forecasts from both sources. In cases where sponsors provide only the forecasts from local procedures, FTA may elect to prepare a STOPS-based forecast as part of the agency's quality-control review.

STOPS may also be useful in ridership forecasting for multiple fixed-guideway projects – as in a system-planning study. The detailed representation of the transit network along with the mode-choice analysis for individual zone-to-zone travel markets makes STOPS at least as sensitive to alternative lengths, alignments, and combinations of fixed-guideway facilities as the typical regional travel model.

Capabilities and Limitations

STOPS is clearly not a substitute for a regional travel model in many other applications. Because STOPS relies on the regional travel model for information on roadway-travel conditions, it cannot be used in highway studies or air-quality conformity analysis. Further, because STOPS focuses on ridership forecasts for fixed-guideways, it cannot be used in forecasting to support bus-system planning studies. Analysts considering a STOPS application should be mindful of its specific capabilities and limitations:

a) Fixed-guideways, not local buses and not roadways. STOPS is designed to quantify the FTA trips-on-project measure for fixed guideway project proposed for New Starts and Small Starts funding. It does not assign trips predicted to use local buses to a bus network. And it relies entirely on the regional travel model for estimates of roadway travel times and distances.

b) Routine weekday travel by residents, not special markets. As with most regional travel models, STOPS focuses on routine travel by permanent residents of the metro area for three trip purposes: home-based work, home-based non-work, and non-home-based. It does not deal with special travel markets (college students, air passengers, etc.) in any geographically specific way. Where these markets are thought to be important to travel on fixed guideways in general and the proposed project in particular, separate methods will be necessary to predict ridership their ridership contributions. Ideally, where these markets are significant, local agencies will already have developed procedures for predicting special-market travel on their transit systems.

c) Transit demand, not limited by transit capacity. Again like most regional travel models, STOPS focuses on the demand for transit given population and employment locations, roadway conditions, and transit service quality. It does not recognize transit capacity limitations and their impacts on transit ridership. Consequently, in its current configuration, STOPS cannot support analyses of projects designed to relieve constraints on transit capacity.

d) Improved representation of work-trip markets, less certain for others. The travel patterns predicted by trip generation and distribution (or destination choice) models in regional travel models generally struggle to capture the realities of travel between home, work, and non-work locations. STOPS avoids these struggles by replacing the models with data. Since these data are tabulations of worker-flows from the CTPP, they are directly applicable to the representation of work-trip patterns. Their applicability to non-work travel is less clear but testing during STOPS development indicated that sufficient similarities exist in the locations of workplaces and non-work activity locations to make the CTPP a useful stand-in for non-work flows. This outcome is fortunate given the absence of CTPP-like data for home-based non-work travel. For non-home-based trips, STOPS uses the predicted locations of home-based transit attractions (work and non-work, summed) to characterize markets for travel between non-home locations. For fixed-guideway planning, this approach might be an improvement over regional models where the non-home-based markets are typically characterized without any reference to the presence of fixed guideway facilities that may affect both the number and destinations of non-home-based trips.

e) Translation of trip patterns over time based on population and employment, not accessibility. STOPS adjusts the travel patterns derived from the 2000 CTPP to represent travel in other years using zone-specific estimates of population and employment that are also used by the regional travel model. These adjustments produce future trip patterns that are consistent with the revised demographics in any given year. However, because the adjustments do not use information on changes in accessibility among various locations – either by roadway or by transit – they cannot represent changes in travel patterns that might result from major increases in roadway congestion or significant improvements in transit service.

f) Recognition of future roadway congestion, but somewhat aggregate impact on buses. Because STOPS uses the zone-to-zone roadway times and distances from the regional travel model, it recognizes the impacts of new roadway facilities and population/employment changes on roadway congestion. However, the GTFS transit network is not associated with roadway conditions in any way: current bus travel times in the GTFS data come from scheduled times rather than as a function of roadway times. To represent future bus travel times, STOPS computes the change over time in roadway travel time for each zone-to-zone movement and then adds that change to the bus runtime between the two zones. This approach is sufficient to recognize big-picture impacts of changes in roadway conditions but clearly does not capture specific impacts on bus runtimes potentially resulting from revised bus routings, street improvements, and other localized changes.

Some current limitations may be addressed by work-arounds that emerge from initial STOPS applications. Others might be resolved by revisions to the component models in a future update of STOPS. For example, a future update that supports the forthcoming CTPP tabulations from the American Community Survey would reduce uncertainties caused by 2000 CTPP data that need to be translated over 13 years' worth of demographic and system changes just to represent the "current year." Meanwhile, analysts should be mindful of their potential implications as they choose between locally developed procedures and STOPS for any travel forecasting application.

Resource Requirements

STOPS offers a substantial reduction in required resources where current travel forecasting procedures maintained locally are insufficient to support reliable forecasts for major transit capital projects. The update, or replacement, of a regional model typically requires survey data collection, model specification and parameter estimation, software preparation, and validation testing before it will be useful in transit forecasting. All of that effort has been completed for STOPS.

A STOPS application will require resources, however, for both its implementation and its subsequent use in preparing forecasts for projects. These resources include:

a) Skills. STOPS requires staff with experience in (1) the application of travel models and software to prepare project-level forecasts, (2) the application of whatever GIS (geographic information system) software package is used currently by the agency or contractor, and (3) familiarity with the nature of transit service and local-agency providers.

b) Time. Initial implementation of STOPS requires the downloading of the software and supporting materials from the FTA website, installing the software and file structure on local computers, and obtaining data from local agencies. This effort may take one to two weeks, depending largely on the ready availability of the data from local agencies. The time needed to prepare forecasts for individual projects may be similar to the time needed with conventional travel models and will depend chiefly on the complexity of the project and associated revisions to existing services in the transit network. The time needed to represent changes to the transit network will be longer for future-year forecasts where the network is expected to change substantially compared to current transit services.

c) Data. STOPS relies on CTPP data and other census products, all of which FTA has bundled together by state and made available for download on the STOPS pages of the FTA website. STOPS also requires the current GTFS data from the local transit provider(s) that is available publicly on the web or directly from each agency. Finally, STOPS requires two kinds of information from the regional travel model: (1) zone-specific population and employment estimates for the year 2000, the current year and, if applicable, for one or more future years; and (2) zone-to-zone roadway travel times and distances, again for the current and, if

applicable, future years. Because STOPS includes an internal, automated procedure to reconcile the geographic definitions used for the CTPP data with the geographic definitions used for demographics and roadway times in the regional travel model, STOPS does not require consistency between these two principal data sources in their underlying geographies.

d) Software. STOPS is a stand-alone software package that requires no additional travel-forecasting software. STOPS does require the use of a GIS software package to code the locations of fixed-guideway stations, define summary districts, and visualize the travel forecasts. The software links automatically to ArcMap (version 10.1) and to the GIS functions in TransCAD (version 5 or version 6). Manual links are available to any other GIS software that handles ESRI-compatible shape files.

e) Computer. STOPS requires a computer with the Windows XP, 7, or 8 operating system, a minimum of 2.0 gigabytes of memory (4.0 gigabytes recommended), and 20-100 gigabytes of storage (perhaps on an external drive) depending on the size of the metro area and its transit system.

Among these requirements, the two most important are skills and time. While STOPS does not require expertise in the development of travel models, its application involves many conventions, data sets, and terminology that are common to conventional travel forecasting. Staff who are well versed in the application of travel models for fixed-guideway transit planning are key to an efficient STOPS implementation. Similarly, while STOPS does not require a significant up-front period for data collection, model development, or testing, its application to project-level forecasting requires sufficient time for:

- transit network coding;
- quality control checks on the forecasts;
- identification of uncertainties in the forecasts;
- preparation and presentation of insights and conclusions about likely project ridership; and
- iterations across alternative project lengths, alignments, and service plans that typically arise through the course of project planning.

The schedule for a STOPS implementation should provide sufficient time for these activities so that the resulting forecasts inform decisions about transit projects rather than simply generate computer files full of numbers.