



IDEA

**Innovations Deserving
Exploratory Analysis Programs**

Transit IDEA Program

Google Transit Data Tool for Small Transit Agencies

Final Report for
Transit IDEA Project 58

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August 2011

TRANSPORTATION RESEARCH BOARD
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Transportation Research Board
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Bruce Williams, PEMCCO, Inc (Transit IDEA project contractor)
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Cort Buchholz and Team Members, Singlemind Consulting, Inc (subcontractor)
Adam Coppin and Team Members, Web Teks, Inc (subcontractor)

Thanks also to the members of the Expert Review Panel (ERP) for this project for the valuable contribution and input. The ERP was formed to provide technical guidance and support to the project team. The panel consisted of subject matter experts and representatives of the transit industry and provided assistance and support to this project. The following members made up the ERP:

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The participation, insight and assistance of the Expert Review Panel was invaluable as the application was transferred from development into practice. It should be useful to small and middle size transit agencies.

Lastly, a special thanks to Harvey Berlin of the Transit IDEA Program of the Transportation Research Board (TRB) for his guidance, participation and assistance.

ABSTRACT

This report discusses the process, results, and work effort carried out in creating a tool to benefit small transit agencies, their current riders and potential new riders. This project included development of a tool to have transit information (routes, start and stop times, trips, fares, and schedules) accessible online via Google Transit. As a result of the tool developed in this Transit IDEA project, solutions are available to small transit agencies at a lower cost and with less resources compared to staff and resources previously needed to accomplish the objective. This project developed a tool that transit agencies can use to provide valid Google Transit data feeds, in accordance with the Google Transit Feed Specification (GTFS), required by Google Transit and other online transit trip planner applications.

Following a successful development cycle (design, coding, and testing) the project pilot testing showed the application and supporting documents to work effectively. The code created is stable and available to provide small transit agencies as an effective method for getting their riders and potential new riders the information they need in a timely manner.

With the application code being open source, it provides a path for possible further development and expansion of functions provided. Those who want to enhance the current application in the future have a method to add specific features.

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EXECUTIVE SUMMARY

This project developed a tool that enables small transit agencies to enter, export and host the transit data needed to put their transit information on Google Transit. While mid to large size transit agencies often have the resources to provide Google Transit data feeds, in accordance with the Google Transit Feed Specifications (GTFS), many small transit agencies do not have the required resources to enter, export and host the required transit data feed, or do not have their data in the required format.

This tool, the Transit Data Feeder (TDF) application developed under this project, is available in two alternative configurations: (1) A hosted configuration, in which an agency contracts with an organization that offers hosting this tool, which minimizes the equipment requirements for the transit agency to a personal computer; and (2) a local web application, which allows an agency to load the application tool into their production environment and host it. For option (2), transit agencies can download the tool from the project web site and use the application within their agency's intranet.

TDF is an application that is released under an Apache open source software license that provides the tool to be open and transferable. Open source software allows the application's "source code" to be accessed by anyone. For agencies choosing to download and internally host the application in their production environment, the tool can be downloaded from the TransitDataFeeder project website (<http://code.google.com/p/transitdatafeeder/>). These are the steps necessary to download the application's source code:

1. Users will need subversion client software to download the code. User not familiar with subversion software can find information and assistance at the following location:
<http://code.google.com/p/support/wiki/SubversionFAQ>
There are many different subversion client software products, some of which are free. Users can choose whatever subversion software they like.
2. To obtain a working copy of the application for your internal use, visit the code "Checkout" page at the TransitDataFeeder project site. The command needed for your subversion client software to checkout/download the source code can be found here:
<http://code.google.com/p/transitdatafeeder/source/checkout>

Further information on using the TDF tool is located in Section 2.4, starting on page 13 of this report.

Having easy and reliable access to up-to-date detailed transit information (route, trip, schedule and fare information) is helpful in the use of today's public transportation services. Using the tool developed in this project, access to this transit information can be made available by agencies previously desiring this capability. In addition to Google Maps and other applications, the Google Transit tool provides an alternative to agencies whose users need on-demand transit information. Offering public transportation users the ability to get current online transit information from their smart phones, laptops, and other computer devices upon request is a tremendous asset. Transit agencies can choose which configuration, internal hosting or using the application from a hosted site, best fits their needs and circumstances.

Publishing an agency's transit information through the Google process has previously only been available to large or substantial medium size agencies. Having the resources to create and maintain transit data in the GTFS format was out of reach for many small transit agencies. With this tool, TDF, small transit agencies can now have a low cost alternative to create and maintain their agency's GTFS

data. This will allow the small transit agencies to provide similar transit information as their large agency counterparts.

This easy-to-use tool will allow small transit agencies to digitally input their transit information in the required GTFS format required by the Google Transit application. This project has accomplished the following:

- Produced an offering for the small transit agency to have a web-based application to enter and export their transit information; and
- Provided a Pilot Program to test a group of five (5) small transit agencies that participated in the project and launched with Google Transit when the development cycle was completed.
- The TDF application is now available for transit agencies to use on provider organization's hosting service or to download and use internally.

1. PROJECT OVERVIEW

1.1 Introduction

Since the release of Google Transit in 2005, many U.S. and non-U.S. transit agencies have launched their agency's transit information on Google Transit. This includes many transit agencies around the world, thus demonstrating universal applicability and interest in Google Transit. This also confirms that providing effective passenger information with web-based trip planners is a widely recognized best practice in the transit industry. Large and many medium size agencies have taken the steps necessary to utilize the offerings by Google Transit and some existing trip planners. The development of this tool is a cost effective solution and alternative that numerous small transit agencies will recognize as a beneficial and necessary resources allowing them to better serve their current and potential future customers. In some cases the agency will take advantage of the offerings and no longer be required to maintain their route maps, trips, and schedule and fare information manually. An easily available, low cost tool able to perform the required functions was our goal.

The Google transit tool team, consisting of project investigators at PEMCCO, software designers and engineers at Trillium, Single Mind, Web Tek's and Google provide the required software engineering, while the participating small transit agencies provided their service and effort in data acquisition and entry as in-kind contribution. Transit practitioner participation in the development process provided user domain expertise to the principal investigation. The team was determined to create a quality product that agencies could quickly integrate into their environment.

1.2 Objectives

Requiring an easily available and cost effective tool lead this project development team to provide an open source web-based tool to enter, export, and host transit data for use by small transit agencies. This allowed those agencies to participate in the Google Transit application environment. The web based tool is available from any web browser and provides the following functions:

- Tool Administration
- Routes Management
- Trips Management
- Stops Management
- Service Schedule Management
- Fare Schedule Management
- Storage for Agency Data
- Creation and Export of GTFS Data Feed

All of these functions are part of the TDF tool. Upon the conclusion of the development and testing phases, the team discovered potential functions that would enhance the capabilities of the application. These future features are described below in section 2.5 and recommend that these items be considered for a follow-on update to this application.

1.3 Recap of Stages

Stage I – Product and Product Realization Planning

Design Team Accomplishments - The design team completed all of the assigned requirements successfully. This team was responsible for the work effort, analysis, and documentation of the following items:

- a. Requirements Matrix
GoogleTransitTool_IDEA_RequirementsMatrix.doc
- b. Design and Development Plan
GoogleTransitTool_IDEA_DesignDevelopmentPlan.doc
- c. Web Application Design Plan
GoogleTransitTool_IDEA_WebApplicationDesignPlan.doc
- d. Technical Approach
GoogleTransitTool_IDEA_TechnicalApproach.doc
- e. Web Application Test Plan
GoogleTransitTool_IDEA_WebApplicationTestPlan.doc
- f. User Training Manual
GoogleTransitTool_IDEA_UserTrainingManual.doc

Development Team Accomplishments - The development team completed all of the assigned requirements successfully and contributed analysis and input to the majority of the documents created during this stage. Their detail and timely input was beneficial in keeping the project on track. Their contribution to the following items (but, is not limited to only these items) was extremely beneficial:

- a. WBS – Work Breakdown Schedule
- b. Web Scheduler Application assessment and leveraging
- c. Application Requirements
- d. Documenting internal data requirements (database schema, input, output, etc.)
- e. Technical Approach
- f. Deliverables review and assessment

Test Team Accomplishments - The test team completed all of the assigned requirements successfully and contributed analysis and input received was incorporated to many of the documents created during this stage. Their detail and timely input was helpful during the completion of this stage. Their contribution to the following items (but, is not limited to only these items) was extremely beneficial:

- a. Design and Development Plan
- b. Deliverables review and assessment

Project Management Accomplishments - The Project Manager (PM) completed all of the assigned requirements successfully and contributed to the input and assessment of the deliverables created during this stage. His assistance in tracking and documenting objectives and milestones has provided for completion of the requirements within the scheduled timeframe. The PM completed the following deliverables as well as contributed to these and other items:

- a. Project Management Plan
GoogleTransitTool_IDEA_PMPlan.doc
- b. WBS
GoogleTransitTool_IDEA_WBS.doc
- c. Communication Plan
GoogleTransitTool_IDEA_CommunicationPlan.doc
- d. Deliverables review and assessment

From a technical prospective, no technical issues existed during this stage. Technical issues were also not expected during the upcoming stages. The Project Team had previous experience with web based transit scheduling products and this knowledge and experience was leveraged, while adding new functions during the development of this tool.

Stage II – Web Application Implementation (Product Provisioning)

Stage II consisted of the work completed, findings and deliverables which occurred during the actual development phase of the Google Transit tool, TDF. The following list details the accomplishments of the team and the technical/operational issues the team confronted during this stage.

Design Team Accomplishments - The design team completed all of the assigned requirements successfully. The design team was responsible for the work effort, analysis, and documentation of the following items:

- User's Guide
GoogleTransitTool_IDEA_UserGuide.doc
- Training Guide
GoogleTransitTool_IDEA_TrainingGuide.doc
- Training Plan
GoogleTransitTool_IDEA_TrainingPlan.doc
- Project Collaboration Website
<http://code.google.com/p/transitdatafeeder/>

With the guidance of the Design Team, the Project Development Team (Design, Development, Test and Project Management) was responsible to identify a Design Freeze Date (when no further design changes would be accepted) and ensure this date was not compromised. However, we fell short of this goal. With the implementation of the Project Website, collaboration between the Project Team, ERP members and other industry experts was greatly enhanced. Issues pertaining to solution usefulness and choice were discussed over this medium and we believe it added to a more inclusive solution alternative.

Development Team Accomplishments - The development team completed all of the assigned requirements successfully and contributed analysis and input to the majority of the documents created during this stage. The development team was responsible for the work effort, analysis, and documentation of the following items:

- Web Application – Transit Data Feeder (TDF) –
<http://datafeeder.trilliumtransit.com/transitdatafeeder/login.seam?cid=6>

- Web Application Test Plan Updates – GoogleTransitTool_IDEA_TestPlan.doc
- Provide code fixes for issues found –
When coding issues or problems were discovered, the team verified the identified issue was an actual problem and determined if the problem required a design change or a coding change. If a coding change was required, the modification was made and returned the application to the test team for further testing. Any issues outside the scope of the application design were identified as a future feature.

The Development Team wrote 13,664 lines of Java code, xhtml, and css (xml files are not included in this number). The total number of database tables created was 46 in the fully operational application. The total number of Unit Test testcases verified was slightly over 100. These testcases covered 95% of the pertinent code. No effort was made to force the creation of Runtime Exceptions. Therefore, exception handling code and single-line “get” and “set” routines (getters/setters) for the Java code (beans) were not covered by the Unit Test.

Test Team Accomplishments - The test team completed all of the assigned requirements successfully and contributed analysis and input to the application solution and many of the documents created during Stage II. The test team was responsible for the work effort, analysis, and documentation of the following items:

- Function Testing
- Systems Testing
- Web Application Test Plan Updates – GoogleTransitTool_IDEA_TestPlan.doc

Function Test scenarios were performed against the TDF web application. The scenarios were aligned into 7 different functional categories:

- Administration
- Routes Management
- Trips Management
- Stops Management
- Service Schedule
- Fare Schedule
- Export of GTFS

A total of 32 testcase scenarios were executed during functional testing. These tests had a 97% success rate, the objective was 95% + to signal the completion of Function Test.

System Test scenarios were performed against the TDF web application. A total of 8 testcase scenarios were identified to verify and validate the inputs, outputs and operations in a standard systems environment. Of the scenarios, 2 were identified as needing the Google Map Parser, which was not available until the Agency Pilot Program Trial Period (Beta Testing) had started. Therefore these test scenarios were verified and validated during Stage III. The remaining testcase scenarios were executed and found to be 100% successful. This identified the completion of System Test with the exception of the 2 identified scenarios.

Project Management Accomplishments - The PM and the project team completed all of the assigned requirements successfully and contributed to the input and assessment of the

deliverables created during this stage. His assistance in attempting to keep the project on track and identifying the situation that required a schedule extension for the application delivery date was essential. Continued tracking and documenting objectives and milestones provided information that kept the team knowledgeable of the progress, expectations and desired goal. The PM completed the following deliverables and contributed to these and other items:

- WBS (updates)
GoogleTransitTool_IDEA_WBS.doc
- Stage II Report
GoogleTransitTool_IDEA_StageIIReport)
- Deliverables review and assessment

Stage II Issues - There were two schools of thought on which team would provide a more comprehensive testing environment, the Development Team due to their familiarity and the previous experience coding and testing transit solutions, or an independent test team experienced in testing many types of software solutions. The decision was made to use an independent test team since their approach would be similar to an application user who was slightly removed from every detail of the internals of the code. This alternative was a quantifiable positive difference in the quality of the testing. Providing the test team with some prior training on a transit scheduling application would have been ideal.

Enhancements discovered after the final design and issues identified during testing were categorized as future features. Information documenting these items is listed in section 2.5 below. It is our hope that someday this group of features may be considered for integration into a follow-on release of this application.

Stage III – Transit Agency User Application

Upon completion of the development and testing cycle, the next step was to utilize the TDF application in a Beta Test environment, which would be similar to using the tool in a production environment. Five (5) small transit agencies were selected to be part of our beta test or sometimes called a pilot program. As part of the pilot program, each agency was provided training and given assistance in preparing their agencies transit information (trips, schedules, stops, fares, etc.) for input into the TDF tool and creation of the GTFS data for Google Transit. The following agencies were identified as part of this Google Transit Tool (TDF) Pilot Project:

- Chatham Area Transit
Savannah, GA
- Lee County Transit (LeeTran)
Ft. Myers, FL
- Park City Municipal Corp
Park City, UT
- Southern Ute Community Action Programs (SUCAP)
Ignacio, CO
- Santee Wateree Regional Transportation Authority (SWRTA)
Sumter, SC

Immediately after the training and while the agencies became familiar with the TDF tool, assessing their individual approach to using the tool in their production environment, it was found that this tool would be particularly useful to small agencies. Agencies with fewer than 100 vehicles operating during peak periods fit into this category. It was determined by LeeTran that they were slightly larger than what the tool was designed to easily handle based on the method currently used to input an agency's transit information into the tool. It was this discovery that identified the need to provide a bulk import function as a requirement. This was noted, listed as a

future feature and not implemented during this release. As a result, the effort to enter LeeTran's data into the tool was outside their planned participation, they ended their beta test involvement. This resulted in the beta test having 4 remaining participants.

At this point during Stage III, the application was loaded into a hosting environment where the 4 transit agencies had access to the tool and free web hosting of their data as it was entered into the TDF. The team collected preliminary details from the trial agencies in preparation for providing assistance to the participants during this stage. The team also worked with Google to shorten the vetting process of the TDF GTFS data for validation.

The Design Team also offered training in the form of a Webinar to all 5 agencies. The training sessions lasted 2 hours and included the requirements for using the TDF tool, the detailed use of the tool and each of the functions available in the tool. Also discussed during the session were details on the validation process of the TDF output (GTFS data) and a period for Q&A.

Next the team helped each of the trial agencies assess their readiness to begin using the TDF tool. The team also provided help with using the TDF tool functions. Between the training and Beta Test involvement, agencies were provided an opportunity to learn and get lots of hands-on-experience.

Each of the 4 agencies created an account on Google's Content Partner Frontend (PCFE). This allowed the agencies to export their GTFS data to Google for their formal preview process. At the time of this report the beta test participants should have entered their transit information into the TDF tool and processed the data and the output from this process should have been validated to determine if the GTFS data is acceptable by Google Transit. Once complete, the agency would need to complete the Google Trip Planner process (where Google would formally review the GTFS data created and provide their findings to the agency for validation). Once validated and the agency is in agreement with the output created, the agency will need to request a launch of their transit data by Google. Google Products and Engineering Team along with their Partner Development Team assisted our participating transit agencies in expediting this process. The latest status of each of our 4 trial agencies is listed below:

- Park City Municipal Corp (Park City, UT)
Transit information published, available on Google Transit privately, public access coming
- Southern Ute Community Action Programs (SUCAP, Ignacio, CO)
Transit information submitted to Google and verify, not yet published
- Chatham Area Transit (Savannah, GA)
Collecting transit information data for entry and processing into TDF
- Santee Wateree Regional Transportation Authority (SWRTA, Sumter, SC)
Completing transit information data entry and processing for Google review

Lastly, the launched data will be published for availability on Google Transit and usable through Google Transit applications.

2. TRANSIT DATA FEEDER

2.1 The Product

GTFS formatted data has become one of, if not, the most widely-used format for public transportation geographic and schedule data in the United States and worldwide. Many applications utilize GTFS, Google Transit (www.google.com/transit) (see Figure 1), and online transit trip itinerary planners that integrate with Google Maps. Timetable Publisher, an open source application that creates print-ready and web-ready timetables, is one such application. The Timetable Publisher was adapted by TriMet from the method developed in Transit IDEA Project 39, *Dynamic Timetable Generator From Schedule Data*. Other applications currently exist and are downloadable from the internet. Many GTFS consuming applications are listed on the GTFS Consumers page of the Headway Wiki (http://headwayblog.com/wiki/index.php?title=Category:GTFS_Consumers).

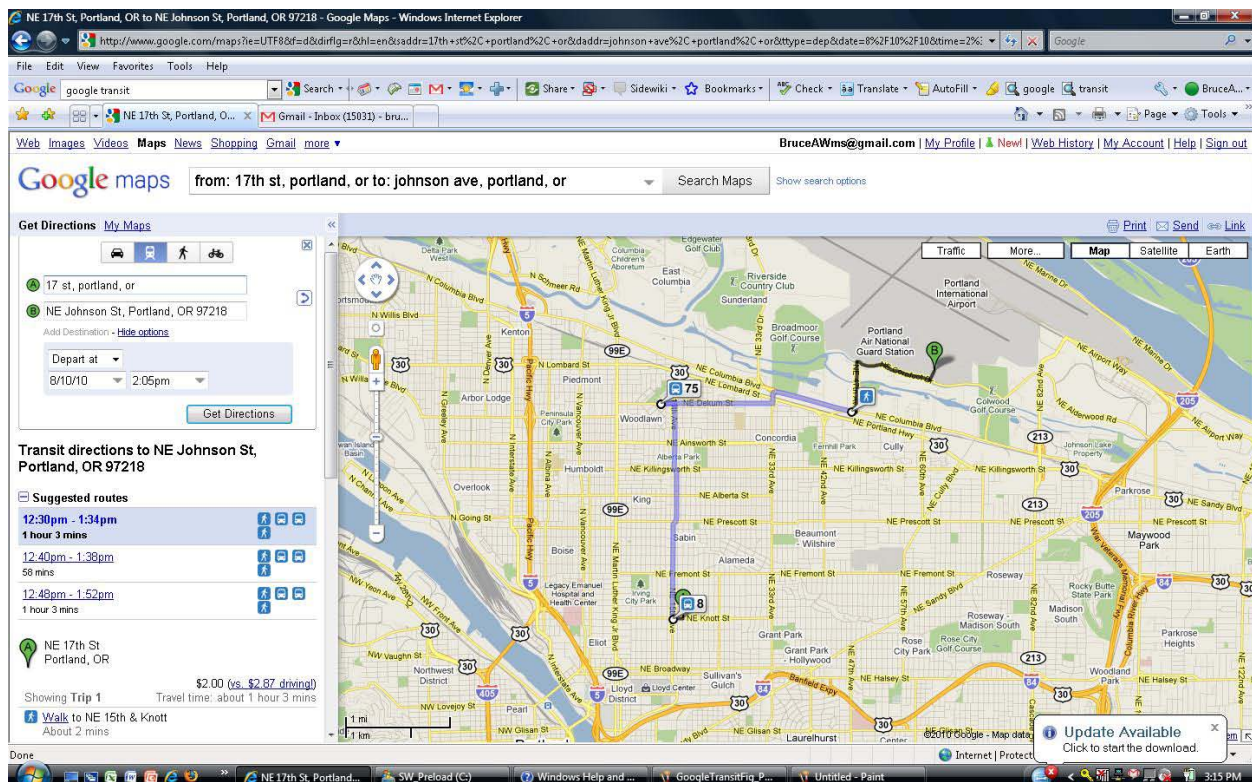


Figure 1 Example of Google Transit results.

The purpose of this application is to enable small, mid-sized, and rural public transportation agencies to manage transit schedules, geographic information, service calendars, and fare data in a user-friendly, web-based interface, and allow for the export of this information in the GTFS format. The intended users, in general, may not be as technologically-savvy or have equal technological resources as their counterparts at large metropolitan public transportation agencies. Therefore, this application was designed to be simple for users with only a basic understanding of transit information and online technologies to use, and is a low cost alternative to deploy and maintain this data.

The application was built using Java 1.6 (Java 6). It runs the most recent stable version (5.1.0.GA) of the Open Source/free JBoss Application Server using version 2.2.0.GA of the JBoss Seam framework. The application components include the following:

- A hosted database to store and access geographic and schedule data.
- Hosted Java software to create, manipulate, and export geographic and schedule data HTML/CSS/JavaScript web-based interface

The overall architecture of the application is based on five core abstract component parts that fulfill essential functions. The application user interface (UI) is designed to orient the user through features such as colored navigational tabs and consistent icons for common functions such as adding, editing, and deleting records. The five essential component parts are listed below. The system and component parts for managing "shapes" or route alignment information comprise extra functionality, which is also included in this release.

- i. Overview dashboard – This module greets the user after log in to provide links to all application functions, it provides an overview and statistics for the currently-selected agency's data previously entered in the system.
- ii. View/create/edit (VCE) data module – This module allows the TDF application user to create, edit, and view detail for records within the application.
- iii. Delete data module – Deletes a selected data record and related records. User confirmation is required before deletion.
- iv. List records module – This module displays records for specified types of data (stops, routes, trips, calendar dates/holidays, blocks, seasonal calendars, fares, zones) as a columnar list.
- v. Data export module – This module exports GTFS data, writing a set of .csv/.txt files and wrapping these into a .zip archive, google_transit.zip.

Final GTFS data feed validation is accomplished outside of this application, by feed_validator.py, which is part of the transit feed distribution. Trip planning is also accomplished outside of this application by Google Transit and other trip planners.

2.2 Transit Industry Impact

Increasing transit ridership is important to help mitigate congestion on the roadways, the environment, provide alternatives to high fuel costs, and to assist in our desire to provide mobility. There is no "silver bullet" to attract transit ridership; this among other actions, implementing transit intelligent transportation systems is recognized as one possible alternative to help increase transit ridership. Web-based trip planners are part of the transit solutions in providing passenger information that can help gain and retain public transportation passengers. Even though the Google Transit (<http://www.google.com/transit>) web-based trip planner is free of charge to transit agencies, there is still effort and cost to transit agencies for providing GTFS data feeds to Google. Traditionally, enterprise level databases with associated applications to manage all aspects of this database are required to provide GTFS data feeds. These are often out of reach for small transit agencies due to capital costs and training needs and may also be impractical due to the complexity of the solution

beyond the actual scope of the GTFS data model. The TDF tool will significantly lower the cost and effort for providing GTFS data feeds:

- TDF is an open source Web application being offered at no charge to users. Users who aspire to process their transit information with the tool and do not have the infrastructure would enter into an agreement with a company providing a hosted configuration solution. With this arrangement, transit agencies are not required to acquire and operate dedicated equipment like database and application servers, as is usually the case with traditional enterprise database solutions.
- TDF focuses on the scope of the GTFS data model, which in comparison to traditional enterprise database solutions reduces the effort for training, data entry and many other traditional components.

There are numerous small transit agencies that can benefit from the use of this tool. Google Transit has received dozens of requests from such agencies. The Colorado Association of Transit Agencies, for instance, is pursuing state-wide Google Transit participation, which includes over 35 small transit agencies that do not have on-line trip planning services. Many of them have less than 10 routes and will require a tool such as TDF to participate in Google Transit. Below is a quote from the Colorado Association of Transit Agencies:

Small transit agencies will benefit from the TDF Web application in the form of a tool to enter, export, host and maintain the transit information needed to participate in Google Transit in a way which is commensurate with small transit agency environments, eventually resulting in increased ridership through improved passenger information.

The TDF application is available in two alternative configurations. (1) A hosted configuration, which minimizes the equipment requirements for the transit agency to a personal computer with internet access and (2) a local web application, which allows an agency to load the application tool into their production environment. The steps necessary to download the application's source code can be found below in Section 2.4 (How to use the Tool) or in the Executive Summary.

As an added benefit, transit data exported by the TDF tool in GTFS can be imported by other existing or future applications like the TimeTable Publisher (TTP), a no cost solution previously mentioned. This transit scheduling solution can be found at this URL: <http://code.google.com/p/timetablepublisher>. TTP includes the ability to read directly from schedule data residing in the GTFS format, not just dynamically from a relational database. It also provides the user with an interface to modify the data for public use and export it for printing and web publication purposes. This is ideal for small transit agencies that lack resources and IT expertise, as it can replace existing manual processes that can be time-consuming and redundant.

2.3 Project Findings

The project team worked hard and consistently during all stages of this project. During the project a few minor technical issues and a few organizational issues were discovered however, none of the issues were critical stopping events and the objectives of the project have been achieved successfully. All of these issues were resolved.

2.3.1 From a technical prospective, no major technical concerns were experienced during any of the 3 stages. The Project Team consisted of personnel with previous experience in

providing web based transit scheduling solutions and this knowledge and experience was leveraged. Initially new functions were added to an existing base, as the project moved forward with the development phase it was determined that new lines of code were required to complete some of the new functional areas. Assembling the right resources was extremely important in the completion of this project.

2.3.2 In was suggested during one of the initial ERP meetings to establish an online collaboration site using Google Projects. This environment was created and was found to be extremely beneficial. The environment allowed us to easily consult with industry experts and team members on issues where solutions required input from real world experience.

2.3.3 Considering transit agency operational flows was a major factor in determining TDF features and how required and optional transit information would be presented to the TDF application user. One of the more complex areas was the handling of Fare Schedules. Figure 2 below is the wireframe used during this discussion.

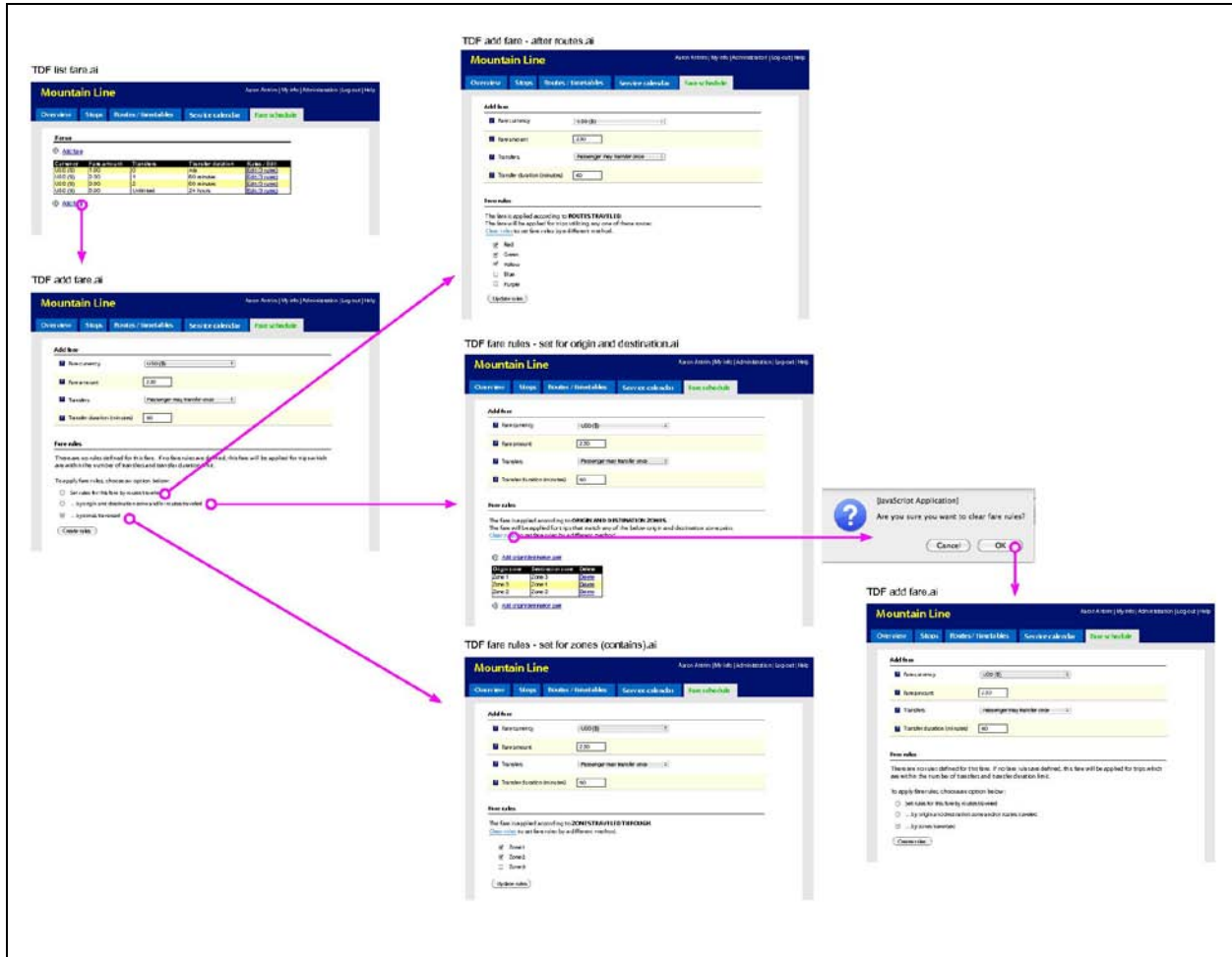


Figure 2 Fare Schedule component wireframe and flow-through.

2.3.4 Determining an open source license was an important step during the development phase. All seem to have some positive and negative features. Apache was our environment of choice; its features best met the requirements of the TDF application.

2.3.5 Team and collaboration website member suggestions along with functional enhancements discovered during testing have been categorized as future features and are listed in section 2.5 below. This group of additional features should be considered in follow-on research and development.

2.4 How to Use the Tool

To use the TDF application, an agency should follow the applicable steps provided below that fit that agency's particular situation. There are alternatives to what is provided, however the following steps are the most direct path to being successful. Begin with organizing all the required data and information for entering into the TDF tool in order to generate the GTFS data feed (stop locations, schedules/timetables, fare schedule, service schedule and holidays).

For stop locations, each stop will need a name as well as latitude and longitude coordinates. If your agency has these coordinates for your stops, please capture (using a spreadsheet for this was helpful). If your agency does not have latitude and longitude coordinates for stops, map-based tools are available for your staff to locate stops during entry.

Request a PCFE (Google Content Partner Frontend) account from Google Transit Partners (googletransit-partners@google.com). This account will allow you to export your generated GTFS data to Google for their preview. Complete a Google Transit Agreement, if your agency has not previously done so.

TDF is released under an open source software license application with an open source code; an agency can internally host the application or, as an alternative, an agency can contact an organization that offers hosting this tool as a service. The organization would provide use of this installed application at a cost, hosting the agency's transit information and providing an administrator UserID / Password for the agency's account and access to the application.

To view the code online, use the following URL in your systems web browser: <http://transitdatafeeder.googlecode.com/svn/trunk/>. You can also, from the TransitDataFeeder project site (<http://code.google.com/p/transitdatafeeder/>), follow this path to view source code modules (select "Source", select "Browse", select "trunk", select "datafeeder", continue selecting the components you'd like to review).

For agencies choosing to download and internally host the application in their production environment, the tool can be downloaded from the TransitDataFeeder project website (<http://code.google.com/p/transitdatafeeder/>). These are the steps necessary to download the application's source code:

1. Users will need subversion client software to download the code. Users not familiar with subversion software can find information and assistance here at this location: <http://code.google.com/p/support/wiki/SubversionFAQ>. There are many different subversion client software products, free and for purchase, use whatever package fits your needs.

2. To obtain a working copy of the application for your internal use, visit the code "Checkout" page at the TransitDataFeeder project site. The command needed for your subversion client software to checkout/download the source code can be found here: <http://code.google.com/p/transitdatafeeder/source/checkout>

Following are the suggested steps when using the TDF application tool after installation or obtaining access to a hosted service:

- Step 1: Login to the account and create your agency and user accounts to allow your identified users to login and begin loading your transit data information. The users will be able to add and manage your agency's stops, routes and timetables, service calendar, holiday exceptions and fares.
- Step 2: Add a service calendar with the annual schedule and weekly calendars.
- Step 3: Add in your agency's holiday exceptions.
- Step 4: Input all of the stops (with longitude and latitude coordinates).
- Step 5: Create and configure all routes and timetables.
- Step 6: Setup all fares.
- Step 7: Generate the GTFS data file.
- Step 8: Process your GTFS data with the feedvalidator.py tool to weed out all of the potential GTFS formatting errors. Once you're satisfied that all errors are removed, move on to the next step (Step 9).
- Step 9: Export your GTFS data to your PCFE account. Google will preview your data and respond with their findings.
- Step 10: Review the Google response and perform Pre-View Testing to verify your transit data has no errors and the data is ready for publishing. Google will provide you with a pre-launch checklist.
- Step 11: Once you believe your data is ready for publishing, complete the pre-launch checklist received during your PCFE request previously. Request the launch of your data and wait for Google's reply.
- Step 12: Once you are notified by Google that your launch is complete, access maps.google.com and go to the area where your transit routes exist and verify your agency's data is available on google maps.
- Step 13: At this point, your transit data has been published and available on Google Transit.

2.5 Future Research

There are potential future enhancements that were discussed during this project that are not included in this release of the TDF application. Most have been discussed with potential

agencies during different stages of this project. These enhancements can be considered if and when future updates are planned for the TDF application.

- 2.5.1 A function that would allow bulk import of data from an Excel spreadsheet or other form of medium used to capture agency bulk transit data like stops, trips and or routes would be extremely useful. Investigate which elements make the most sense and save the most time.
- 2.5.2 Determine if there's a way to add options/buttons other than "Save" and "Cancel" when adding stop or other criteria. If so, it would be helpful to have a "Preview" button that can be clicked after initially entering the data so the editor can check placement on the map before saving. It would also be helpful to have a "Save and Add New" button so the editor can go right into adding another stop after saving rather than being brought to the Stop List page.
- 2.5.3 According to issue details provided, Agency Search was not an option being provided in this release. If so, how does one search for an agency and does this require knowledge of the agency's time zone? Based on the design, and in our opinion, since modification of an agency's entry requires admin access, the assumption is an agency administrator would know the time zone of its own agency. However, consider adding a feature to indicate knowledge of the agency time zone is required.
- 2.5.4 Based on the responses researched, the current system will allow incorrect data to be entered into the system by the users. Therefore, the system could generate GTFS data that will fail validation. A data entry module should be considered to prevent erroneous data from being entered. Data validation could be based on the entry criteria and out of scope replies.

Of these issues, having a bulk import feature for agency data would be an extremely helpful function. This would have reduced the amount of manual input time tremendously. Even agencies defined as a small agency (less than 100 vehicles active during peak periods) could possibly have hundreds of stops. For example, one of the trial agencies only has 39 vehicles at peak periods, but has in excess of 250 stops. Manually adding 250 stops was very time consuming. Having an automated way to import this data would have been useful.

3. CONCLUSIONS

This report discusses the process, results and work done to create an open source web based tool needed in the small to medium size transit agency arena. The tool enables those with limited resources and limited technical expertise to build GTFS data from their agency's transit information. With the GTFS data stream, a transit agency has the opportunity to use the Google Transit online trip planner via Google Maps and with other online transit scheduling applications. Our Beta Test results successfully demonstrated that the TDF tool will create the GTFS data streams needed to provide agency transit information to riders and potential riders of a small or medium size transit property. Having an open collaboration medium was very successful in sharing the work being done and having an open forum to discuss ideas and solutions.

Figure 3 below, shows an example of what can be accomplished through the use of the TDF application. Park City Transit in Utah was a Pilot Program (Beta Test) participant in this project. The example is a trip planned on their transit system through Google Transit.

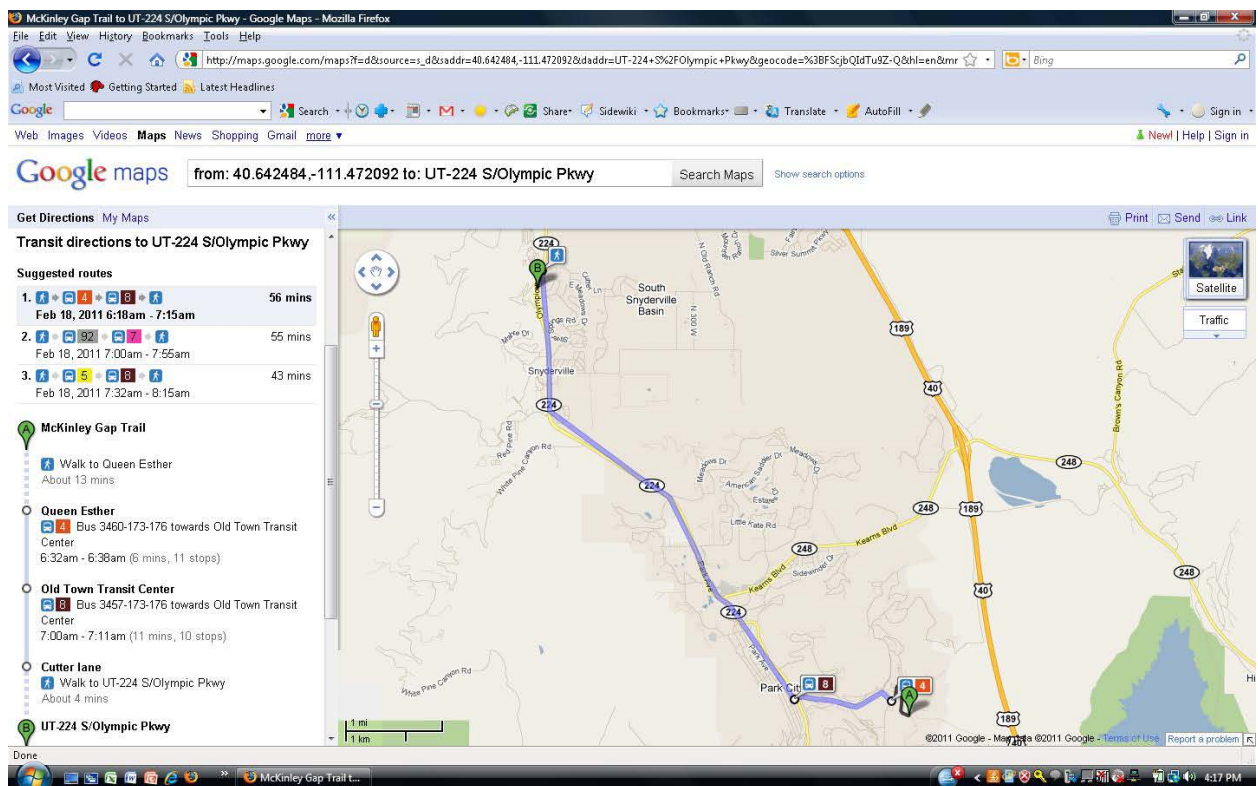


Figure 3 Example of a Google Transit result for Park City Transit

Agencies and technology organizations can add functionality and capabilities if they desire. Our straight forward approach and use of standardized components should make enhancing the tool possible in the future.

This tool provides a viable solution for many transit agencies and enables small transit agencies to enter and export the transit data needed to put their transit information on Google Transit.

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5. REFERENCES

Google Transit Feed Specifications
http://code.google.com/transit/spec/transit_feed_specification.html

GTFS Consumers
http://headwayblog.com/wiki/index.php?title=Category:GTFS_Consumers

Transit IDEA Project 39, *Dynamic Timetable Generator from Schedule Data*,
Paula Okunieff

6. GLOSSARY

Apache	A web server software product
css	Cascading Style Sheets Language
GTFS	Google Transit Feed Specification
Java	A programming language that is computer architecture independent
Java EE	Java Enterprise Edition, a widely used platform for server programming in Java
JBoss	A free software open source Java EE based application server
open source	Computer software that is available in source code form for which the source code and certain other rights are provided under a software license that permits users to study, change, and improve the software
Wiki	A website that allows the easy creation and editing of integrated web pages
wireframe	A wireframe in website application design is a visual guide used to document the structure of a website and the relationships between its pages. It's an illustration of the layout.
xhtml	Extensible Hypertext Markup Language
Xml	Extensible Markup Language
zip	A file format used for data compression and archiving