A Global Transit Innovations (GTI) Data System

TRANSIT SERVICE FREQUENCY APP

Methodology Report

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GLOBAL TRANSIT INNOVATIONS

UNIVERSITY OF MINNESOTA

Citation of the Transit Service Frequency App

Publications and research reports based on the Transit Service Frequency App must cite it appropriately. The citation should include the following:

> Fan, Yingling, Peter Wiringa, Andrew Guthrie, Jingyu Ru, Tian He, Len Kne, Shannon Crabtree. *Transit Service Frequency App: A Global Transit Innovations Data System* [Machine-readable database]. Minneapolis: University of Minnesota, 2018. Available at http://gti.umn.edu/data/.

Overview

The Transit Service Frequency App hosts stop- and alignment-level service frequency data from 559 transit providers around the globe who have published route and schedule data in the General Transit Feed Specification (GTFS) format through the TransitFeeds website, a global GTFS clearinghouse. Stop- and alignment-level service frequency is defined as the total number of transit routes and transit trips passing through a specific alignment segment or a specific stop location. The app makes data easily accessible through visualization and download tools.

The visualization tool displays the following GIS layers (Figure 1):

- A layer showing the geographic service extent of each transit provider;
- A layer showing the locations of transit stops, and providing stop-level service frequency data in total number of routes and total number of trips by transit mode (bus, rail, and other) and by weekday/weekend;
- A layer showing the alignments of transit routes, and providing alignment-level service frequency data in total number of routes and total number of trips by transit mode (bus, rail, and other) and by weekday/weekend;

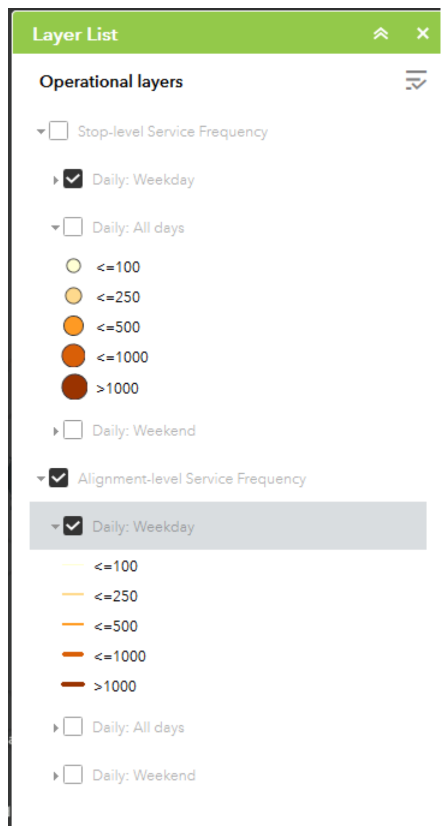

Figure 1. Layers in the App

Users can click on the geographic service extent of each transit provider and zoom to a specific transit provider area. Users can also use the search box to zoom to a specific place, e.g., Minneapolis, MN, USA or Berlin, DEU. Figure 2 illustrates the returned visualizations using the place-based search tool.

Figure 2. Returned weekday alignment-level service frequency visualizations using the place-based search tool

Users can click on each visualized street segment or stop for alignment-level or stop-level service frequency information. For example, as shown in Figure 3, if users click on the Hollywood Boulevard street segment that is right before the Dolby Theatre, the selected street segment has a weekday route frequency of five (4 bus and 1 rail) and a weekday trip frequency of 617 (415 bus and 202 rail). This means that, on average, five operational transit routes passing by this Hollywood Boulevard street segment during weekdays. These five routes together provide 415 bus trips and 202 rail trips passing by this Hollywood Boulevard street segment.

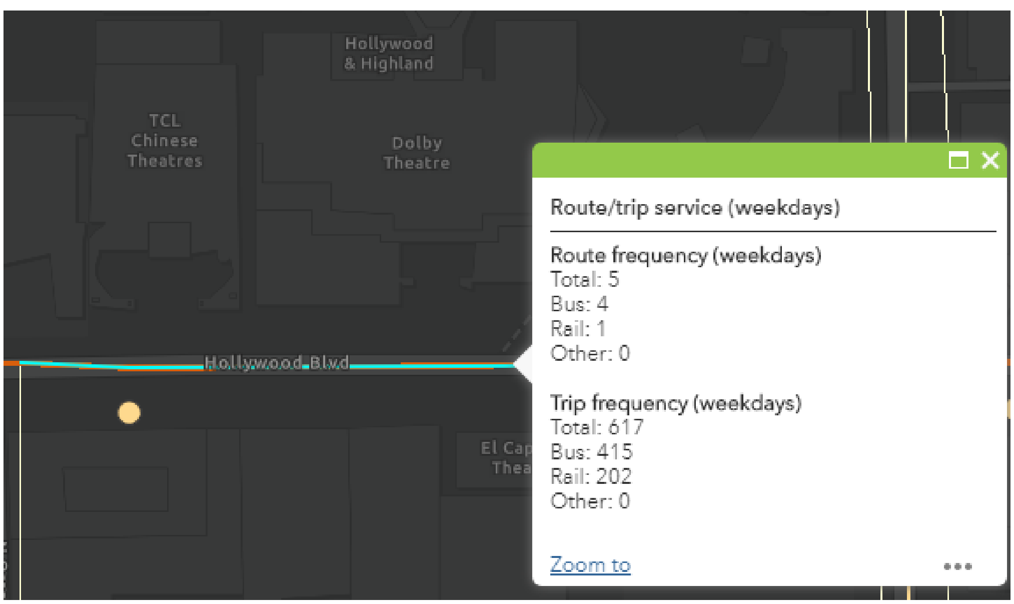

Figure 3. Alignment-level transit service frequency on a specific Hollywood Boulevard street segment

The download tool allows for three types of downloads:

- Download data for a specific individual transit provider: Individual provider downloads are available via provider pop-ups.
- Download data for a set of transit providers (up to 100) whose service extents intersect user-defined polygons: User delineate the polygons using polygon drawing tools (see Figure 4).
- Download the complete dataset: The complete dataset is available for download as a single ZIP file from the information panel of the mapping application.

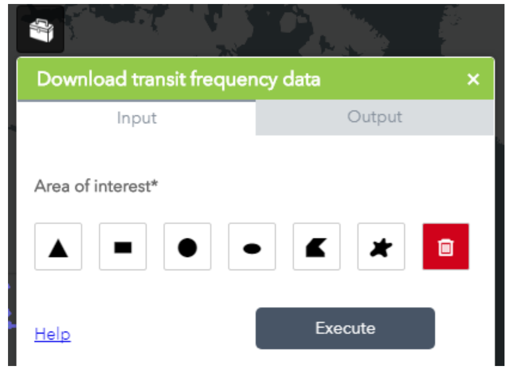

Figure 4. User can click the toolbox icon to access polygon drawing tools

For each data download, the output zip file contains a README file that describes the downloaded data. Because stop- and alignment-level service frequency data are aggregated counts of routes and trips passing through each stop and each street segment, the data are stored differently dependent upon whether the download includes a single or multiple transit providers:

- If the download includes a single transit provider, the stop- and alignment-level service frequency data are stored respectively in the "provider_stop_loading" and "provider_segment_loading" file folders.
- If the download includes multiple transit providers, the stop- and alignment-level service frequency data are stored respectively in the "aggregated_stop_loading" and "aggregated_segment_loading" file folders. Note that "provider_stop_loading" and "provider_segment_loading" files are also provided because these files are intermediate files for generated "aggregated_stop_loading" and "aggregated_segment_loading" files.

In addition to stop- and alignment-level service frequency data that are aggregated counts of routes and trips, the output zip file contains route-level files with desegregated, route-level trip frequency information. These route-level files are the intermediate files generated to calculate the aggregated counts of routes/trips passing through specific stops/streets. These files are stored in the "route_shapes" and "routes" file folders.

Table 1 summarizes the providers, routes and stops included, as well as the countries they are from. The data contain a total of 42,173 routes, and 973,356 stops in 46 countries across the globe. For a detailed list of all providers included in the app, see Appendix A.

Though intended as a global standard, the GTFS format has been most widely adopted in the United States and Canada. As such, systems from these countries are best represented in the app.

Table 1: Providers, routes and stops by country

Continent	Country	Providers	Routes	Stops
Africa	Kenya	1	133	2,467
Asia	Israel	1	7,425	24,862
	Japan	2	354	2,783
	Jordan	1	4	1
	Palestinian Territory	1	1,794	2,720
	Philippines	1	20	4,871
	Syria	1	168	338
	Thailand	9	78	2,405
Europe	Austria	3	285	4,403
	Belgium	4	162	2,912
	Bosnia and Herzegovina	1	6	10
	Bulgaria	1	1	3
	Croatia	1	48	102
	Czech Republic	3	490	7,013
	Denmark	1	67	40
	Estonia	1	1,859	14,707
	Finland	2	714	10,535
	France	6	304	5,629
	Germany	4	1,800	36,502
	Hungary	5	598	7,165
	Ireland	1	125	4,689
	Italy	15	2,642	23,112
	Latvia	1	105	1,655
	Lithuania	5	257	3,100
	Luxembourg	1	6	5
	Macedonia	1	1	2
	Netherlands	3	2,812	48,926
	Norway	2	151	3,784
	Poland	7	139	1,661
	Portugal	1	7	56
	Romania	1	26	101
	Serbia	1	6	5
	Slovakia	1	19	16
	Slovenia	1	38	6
	Spain	10	536	10,970
	Sweden	1	8	23
	Switzerland	2	47	15
	Ukraine	1	1	5
	United Kingdom	2	10	55
North America	Canada	67	4,274	121,755
	Mexico	1	145	5,962
	United States	391	10,940	483,791
Oceania	Australia	27	5,179	106,819
	New Zealand	2	1,842	13,612

Continent	Country	Providers	Routes	Stops
South America	Argentina	2	11	228
	Brazil	3	378	15,535

DATA SOURCES

The Transit Service Frequency App relies on the GTFS data format, which provides the source data for Google Maps' transit directions feature. GTFS provides a convenient, standardized, open-source format for highly detailed transit route and schedule data. In addition, many transit providers freely publish their GTFS data for use by app developers and researchers. Data used to create the Transit Trip Frequency App come from TransitFeeds, which hosts publicly available GTFS data for use in web development and research at http://transitfeeds.com/. The authors used Python code to batch download all available GTFS feeds from the TransitFeeds website.

Each provider included in the app produces a GTFS feed, which comprises a number of comma-delimited text files describing the essential information about the services they operate. The GTFS files used from each feed included in the Transit Trip Frequency App are listed in Table 2, along with a description of critical fields from each table.

It must be noted that not all transit systems with GTFS data available from TransitFeeds participate in the app. The GTFS data format is designed to be flexible, with as low a bar for entry, so to speak, as possible. As such, GTFS supports a number of optional tables, which provide richer information about transit service, but are not necessary for the basic transit directions functionality. The **shapes.txt** data used by the app to determine geographically accurate routes *between* stops is optional. No effort was made to estimate missing routes. As a consequence, the app is unable to display information on GTFS feeds that do not include a **shapes.txt** source file. In all, the app includes 559 transit providers' feeds. (Country level provider counts in Table 1 do not add up to the total number of feeds due to the fact that some intercity rail and bus operators included in the app cross national borders, particularly in Europe.)

Table 2: GTFS tables employed

Table	Field	Description
shapes.txt Describes the geographic extent of each transit route.	shape_id	Uniquely identifies each shape
	shape_pt_lat	Latitude of one point of the route
	shape_pt_lon	Longitude of one point of the route
	shape_pt_sequence	Order in which the point described is visited
routes.txt Identifies and provides basic information on each route in the feed.	route_id	Uniquely identifies each route
	agency_id	Uniquely identifies each transit provider
	route_short_name	Abbreviated route name
	route_long_name	Detailed route name
	route_desc	Additional route description, i.e. destination, etc.
	route_type	Transit mode
stops.txt Identifies and locates each stop in the feed.	stop_id	Uniquely identifies each stop
	stop_name	Stop name
	stop_lat	Latitude of stop
	stop_lon	Longitude of stop
stop_times.txt Lists arrival and departure times at stops and the sequence in which they are served.	trip_id	Uniquely identifies each trip of each route
	stop_id	Uniquely identifies each stop
	stop_sequence	Order in which the trip visits each stop
trips.txt Identifies each individual trip of each route.	route_id	Uniquely identifies each route
	service_id	Uniquely identifies each day's service on each route
	trip_id	Uniquely identifies each trip of each route
	shape_id	Uniquely identifies each shape
calendar.txt Identifies the day of the week each trip operates.	service_id	Uniquely identifies each day's service on each route
	monday	Binary fields identifying what days a service operates.
	tuesday	
	wednesday	
	thursday	
	friday	
	saturday	
	sunday	
calendar_dates.txt Adds or removes service on specific dates, as for special events or holidays.	service_id	Uniquely identifies the service
	date	The date on which the exception applies
	exception_type	Identifies whether the service is being added or removed
frequencies.txt Describes service intervals and trip spacing for frequency-based trips.	trip_id	Uniquely identifies each trip of each route
	start_time	Start time for frequency-based service
	end_time	End time for frequency-based service
	headway_seconds	Number of seconds between departures

STUDY AREA

Each transit provider's service area is derived by inscribing a rectangle around the extremes of the system's extent, as defined by the GTFS **shapes.txt** file, using the rectangle by area option in ArcGIS Desktop's Minimum Bounding Geometry tool. Each such service area is rotated to show the extent of systems included in the app at the global scale, as well as details of the continental United States, Europe and East Asia.

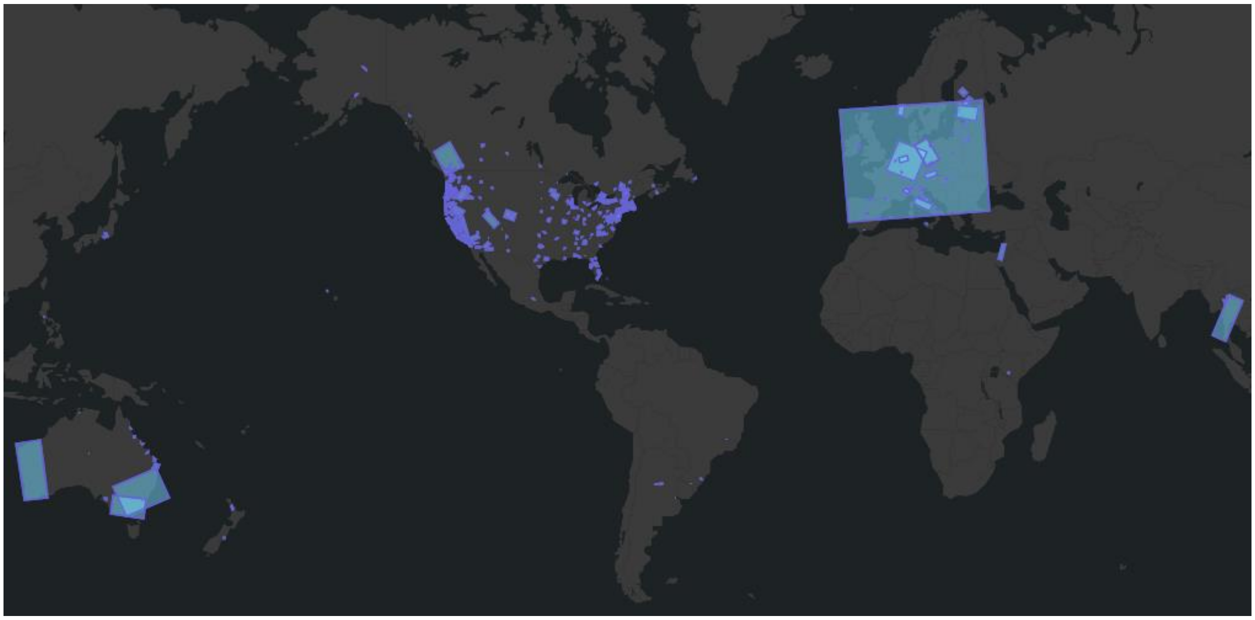

Figure 5: Global extent of systems included

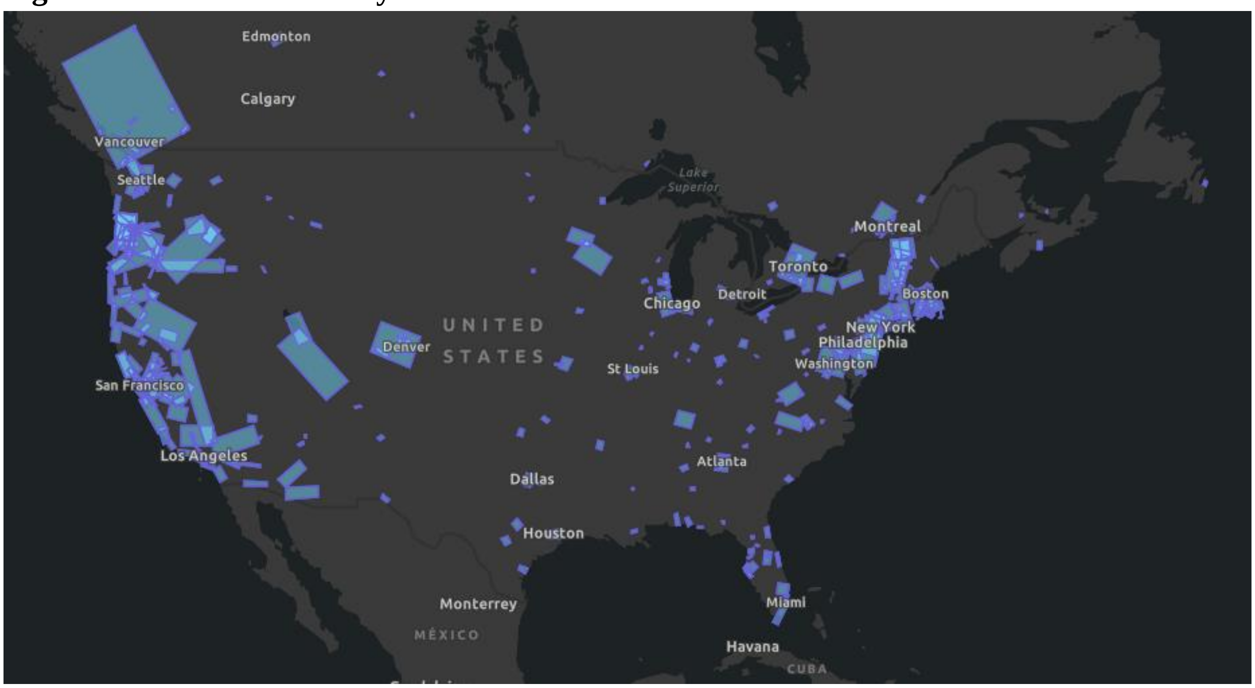

Figure 6: Extent of systems included, contiguous United States and Canada

Figure 7: Extent of systems included, Europe

Figure 8: Extent of systems included, East Asia, Australia, New Zealand

MEASURING TRANSIT SERVICE FREQUENCY

The Transit Service Frequency App measures the frequency of transit services at the level of alignment segments and stop locations—that is, the total number of transit routes and transit trips passing through a specific alignment segment or a specific stop location. The app derives polylines describing the physical locations of routes directly from the **shapes.txt** file in each provider's GTFS feed. Key fields—fields which appear in more than one table and serve as a link between tables—in the GTFS data allow the connection of shapes with routes, routes with service levels, separated by weekdays and weekends and routes with the stops they serve, as shown in Figure 9.

The **trips.txt** file (shown at center) is critical for linking the other original GTFS tables needed to create shapefiles describing the shapes and service frequencies of specific routes, which are spatially aggregated to produce segment loadings—portions of a route with a consistent level of service including average daily, weekday and weekend day bus, rail and other route and trip counts. Segment loadings are combined with the **stops.txt** file to produce stop loadings—average day, weekday and weekend day counts of routes and trips serving each individual stop. This process is shown in Figure 10 and described in detail below.

Daily trip counts are based on an average day, weekday and weekend day on which regular service operates—in other words, a typical day which is not a holiday and has no special event service. Non-typical service days are identified using the **calendar_dates.txt** file, which allows providers to add or remove service for a specific date or set of dates. Providers may either leave normal service operating and add additional special service (as for a special event like a state fair, for instance), or remove their normal service and add an entire system of special service (as for a holiday with limited service, for instance). It is difficult to automatically determine which method of modifying service a provider is using for any given date. As a result, the app excludes all dates which appear in **calendar_dates.txt**, except in cases where the provider's schedule is based entirely on **calendar_dates.txt**. Once these dates are excluded, we construct a calendar range, containing the sum of all weekdays and weekend days on which service described by the feed in question operates. We then divide the total number of trips for the entire range, weekdays in the range and weekend days in the range by the total number of days in each to calculate average trips per day, weekday and weekend day.

Route-level trip counts are calculated by linking the **routes.txt** file to the **trips.txt** file and deriving trip occurrences using the **calendar.txt**, **calendar_dates.txt**, and **frequencies.txt** files. The shape_id field in the resulting table links trips counts to **shapes.txt**, allowing the creation of **provider_<PID>_route_shapes.shp**—a shapefile for provider PID describing the shape of a route that also includes information on its mode, weekday trips, and weekend trips. Since multiple routes may share a single street or stretch of track, and may not have identical geometries, route shapes are manipulated using the Simplify Line and Integrate tools in ArcGIS Desktop. These operations, when combined, align portions of routes that do overlap. These better-aligned geometries produce **provider_<PID>_segment_loading.shp**, which has a single feature for each route segment with attributes listing the count of bus, rail and other routes and trips serving the segment on an average day, weekday and weekend day.

Stop-level trip counts and routes served are determined using the **routes.txt**, **trips.txt**, **stops.txt**, and **stop_times.txt** files, combined with the previously constructed calendar range. The stop_id field is used to count route service and trips for individual stops and a **provider_<PID>_stops.shp** file is produced for each GTFS provider, with points representing in-use stops and attribute data akin to the route shapes files (routes and trip frequency broken down by route type and day range).

Nearby stops are grouped by provider, using the Integrate tool in ArcGIS desktop with a 30-meter tolerance, to produce **provider_<PID>_stop_loading.shp** files. Trip frequency attributes are summed across geometrically coincident stop points into this new file. Route-count attributes are retained and also summed. It should be noted that route counts attached to combined stop-points will over count the number of routes served when opposing-direction stops served by the same route are combined, but will not over count route-shapes (e.g., eastbound and westbound buses of the same route following different shapes). Over counting may occur if stops serving the same route-shape occur within the specified tolerance.

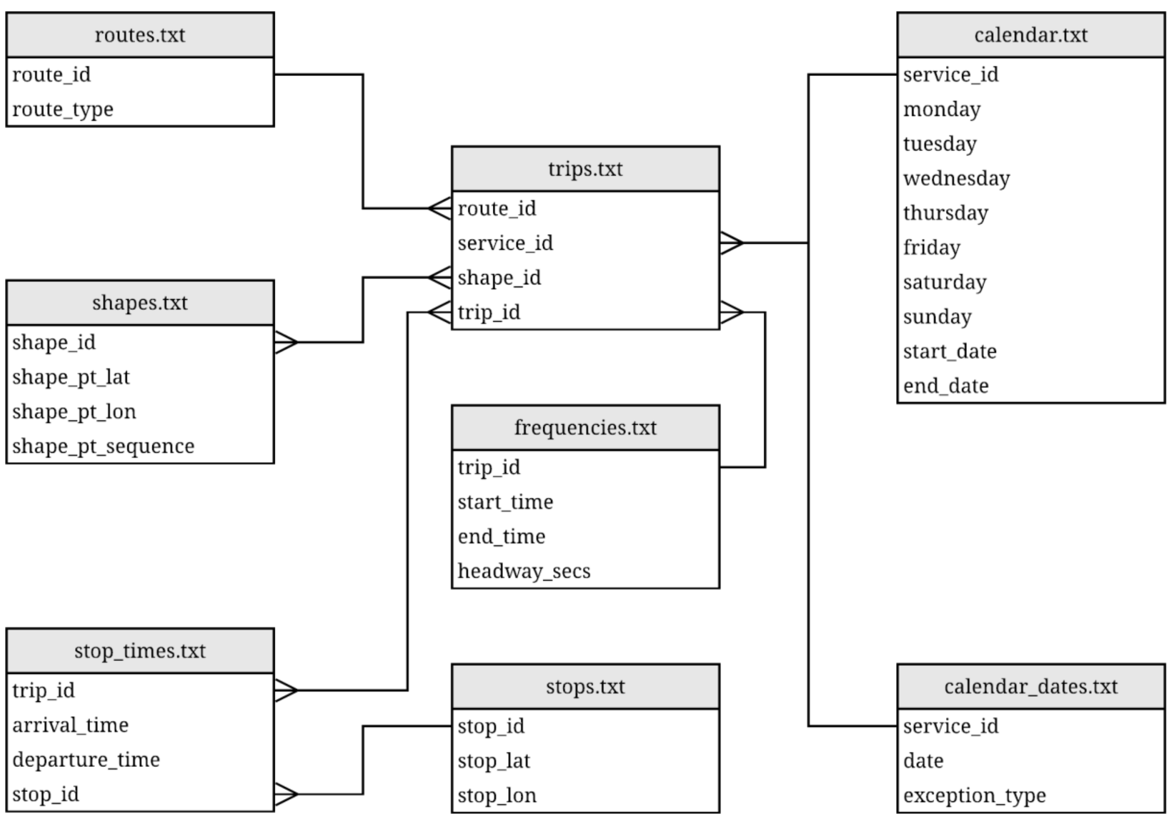

Figure 9: GTFS database schema

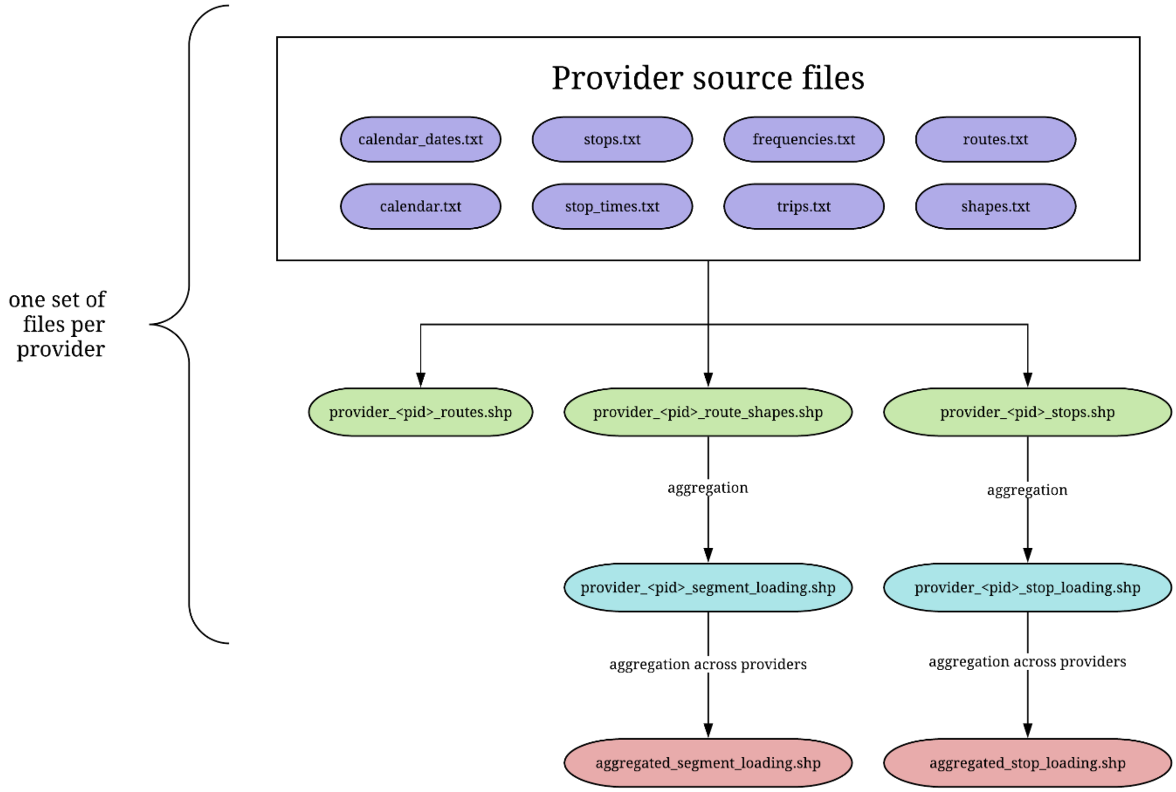

Figure 10: Workflow for download production

Finally, the **provider_<PID>_segment_loading.shp** files are merged to produce **aggregated_segment_loading.shp**. Geometries are again integrated to align segments across overlapping providers; route and trip frequency attributes are aggregated and attached to this multi-provider geometry. The full set of **provider_<PID>_stop_loading.shp** files is similarly merged, integrated, and attribute values aggregated to produce **aggregated_stop_loading.shp**. Geometries and attributes from these aggregated files are displayed in the application.

Table 3 provides a comprehensive list of all download contents and their attributes.

Table 3: Download contents

File	**Field**	**Description**
README.txt	n/a	Lists download contents and their attributes.
feeds.csv Lists all GTFS feeds used in the app.	fid	Unique feed identifier from TransitFeeds.com
	fnid	Numeric component of fid (remains unique)
	name	Feed (provider) name
	lname	Location short name – Describes area served
	lfullname	Location long name – Describes area served
	lat	Location latitude (WGS84)
	lng	Location longitude (WGS84)

<table>
<tr><th>File</th><th>Field</th><th>Description</th></tr>
<tr><td rowspan="2">route_types.csv
Route types (detailed modes) included in data processing, from GTFS route types and extended route types</td><td>route_type</td><td>Unique identifier for route type/mode</td></tr>
<tr><td>desc</td><td>Route type/mode description</td></tr>
<tr><td rowspan="2">route_groups.csv
Route types (simplified modes) included in data processing, from GTFS route types and extended route types</td><td>route_grp</td><td>Unique identifier for route group/mode</td></tr>
<tr><td>desc</td><td>Route group/mode description</td></tr>
<tr><td rowspan="4">provider_<PID>_routes.shp
Routes for provider <PID></td><td>fnid</td><td>Numeric component of the feed provider ID (fid)</td></tr>
<tr><td>route_id</td><td>Provider-level unique route identifier</td></tr>
<tr><td>route_type</td><td>Code for GTFS route type or extended route type</td></tr>
<tr><td>route_group</td><td>Encoded route group (1=bus, 2=rail, 3=other)</td></tr>
<tr><td rowspan="13">provider_<PID>_route_shapes.shp
Route-shapes for provider PID, with separate geometry and attributes for each shape-based variant of a route</td><td>fnid</td><td>Numeric component of the feed provider ID (fid)</td></tr>
<tr><td>route_id</td><td>Provider-level unique route identifier</td></tr>
<tr><td>shape_id</td><td>Provider-level unique shape identifier</td></tr>
<tr><td>route_type</td><td>Code for GTFS route type or extended route type</td></tr>
<tr><td>route_group</td><td>Encoded route group (1=bus, 2=rail, 3=other)</td></tr>
<tr><td>basis</td><td>Number of calendar days used as the basis for counting total trips and determining frequency</td></tr>
<tr><td>basis_wd</td><td>Number of calendar days for weekdays</td></tr>
<tr><td>basis_we</td><td>Number of calendar days for weekend-days</td></tr>
<tr><td>freq</td><td>Average number of daily trips (all frequencies rounded to nearest tenth)</td></tr>
<tr><td>freq_wd</td><td>Average number of weekday trips</td></tr>
<tr><td>freq_we</td><td>Average number of weekend-day trips</td></tr>
<tr><td>dep_first</td><td>Earliest departure from a stop on the route-shape</td></tr>
<tr><td>arr_last</td><td>Latest arrival at a stop on the route-shape</td></tr>
<tr><td rowspan="23">provider_<PID>_stops.shp
Locations of and numbers of trips serving stops for provider <PID></td><td>fnid</td><td>Numeric component of the feed provider ID (fid)</td></tr>
<tr><td>stop_id</td><td>Provider-level unique stop identifier</td></tr>
<tr><td>r</td><td>Count of routes serving the stop</td></tr>
<tr><td>r_[bus|rail|other]</td><td>Number of routes in a group (simplified mode) serving the stop</td></tr>
<tr><td>r_wd</td><td>Count of routes serving the stop on weekdays</td></tr>
<tr><td>r_wd_[bus|rail|other]</td><td>Weekday count by group</td></tr>
<tr><td>r_we</td><td>Count of routes serving the stop on weekend days</td></tr>
<tr><td>r_we_[bus|rail|other]</td><td>Weekend count by group</td></tr>
<tr><td>b</td><td>Number of calendar days used as the basis for counting total trips and determining frequency</td></tr>
<tr><td>b_[bus|rail|other]</td><td>Number of calendar days by route group</td></tr>
<tr><td>b_wd</td><td>Number of calendar days for weekdays</td></tr>
<tr><td>b_wd_[bus|rail|other]</td><td>Number of calendar days for weekdays by route group</td></tr>
<tr><td>b_we</td><td>Number of calendar days for weekend days</td></tr>
<tr><td>b_we_[bus|rail|other]</td><td>Number of calendar days for weekend days by route group</td></tr>
<tr><td>f</td><td>Average number of daily trips (all frequencies rounded to nearest tenth)</td></tr>
<tr><td>f_[bus|rail|other]</td><td>Average number of daily trips by route group</td></tr>
<tr><td>f_wd</td><td>Average number of weekday trips</td></tr>
<tr><td>f_wd_[bus|rail|other]</td><td>Average number of weekday trips by route group</td></tr>
<tr><td>f_we</td><td>Average number of weekday trips</td></tr>
<tr><td>f_we_[bus|rail|other]</td><td>Average number of weekend day trips by route group</td></tr>
</table>

<table>
<tr><th>File</th><th>Field</th><th>Description</th></tr>
<tr><td rowspan="13">provider_<PID>_stop_loading.shp
Locations of and numbers of trips serving stop groups (nearby stops) for provider <PID></td><td>fnid</td><td>Numeric component of the feed provider ID (fid)</td></tr>
<tr><td>r</td><td>Count of routes serving the stop group</td></tr>
<tr><td>r_[bus|rail|other]</td><td>Number of routes in a group (simplified mode) serving the stop group</td></tr>
<tr><td>r_wd</td><td>Count of routes serving the stop group on weekdays</td></tr>
<tr><td>r_wd_[bus|rail|other]</td><td>Weekday count by group</td></tr>
<tr><td>r_we</td><td>Count of routes serving the stop group on weekend days</td></tr>
<tr><td>r_we_[bus|rail|other]</td><td>Weekend count by group</td></tr>
<tr><td>f</td><td>Average number of daily trips (all frequencies rounded to nearest tenth)</td></tr>
<tr><td>f_[bus|rail|other]</td><td>Average number of daily trips by route group</td></tr>
<tr><td>f_wd</td><td>Average number of weekday trips</td></tr>
<tr><td>f_wd_[bus|rail|other]</td><td>Average number of weekday trips by route group</td></tr>
<tr><td>f_we</td><td>Average number of weekday trips</td></tr>
<tr><td>f_we_[bus|rail|other]</td><td>Average number of weekend day trips by route group</td></tr>
<tr><td rowspan="13">provider_<PID>_segment_loading.shp
Aggregated route counts and trip frequencies for a provider, with geometries integrated to a tolerance of 3 meters to combine nearby segments</td><td>fnid</td><td>Numeric component of the feed provider ID (fid)</td></tr>
<tr><td>r</td><td>Count of routes serving the segment</td></tr>
<tr><td>r_wd</td><td>Count of routes serving the segment on weekdays</td></tr>
<tr><td>r_we</td><td>Count of routes serving the segment on weekend days</td></tr>
<tr><td>r_[bus|rail|other]</td><td>Count of routes serving the segment by route group</td></tr>
<tr><td>r_[bus|rail|other]_wd</td><td>Count of routes serving the segment on weekdays, by route group</td></tr>
<tr><td>r_[bus|rail|other]_we</td><td>Count of routes serving the segment on weekend days, by route group</td></tr>
<tr><td>f</td><td>Average number of daily trips on the segment (all frequencies rounded to nearest tenth)</td></tr>
<tr><td>f_wd</td><td>Average number of weekday trips</td></tr>
<tr><td>f_we</td><td>Average number of weekend day trips</td></tr>
<tr><td>f_[bus|rail|other]</td><td>Average number of daily trips by route group</td></tr>
<tr><td>f_[bus|rail|other]_wd</td><td>Average number of weekday trips by route group</td></tr>
<tr><td>f_[bus|rail|other]_we</td><td>Average number of weekend day trips by route group</td></tr>
<tr><td rowspan="12">aggregated_segment_loading.shp
** This shapefile not included for individual provider downloads **
Aggregated segment loading across providers (i.e., overlapping provider segment loading data is combined), clipped to the extent specified when generating the download.</td><td>r</td><td>Count of routes serving the segment</td></tr>
<tr><td>r_wd</td><td>Count of routes serving the segment on weekdays</td></tr>
<tr><td>r_we</td><td>Count of routes serving the segment on weekend days</td></tr>
<tr><td>r_[bus|rail|other]</td><td>Count of routes serving the segment by route group</td></tr>
<tr><td>r_[bus|rail|other]_wd</td><td>count of routes serving the segment on weekdays, by route group</td></tr>
<tr><td>r_[bus|rail|other]_we</td><td>Count of routes serving the segment on weekend days, by route group</td></tr>
<tr><td>f</td><td>Average number of daily trips on the segment (all frequencies rounded to nearest tenth)</td></tr>
<tr><td>f_wd</td><td>Average number of weekday trips</td></tr>
<tr><td>f_we</td><td>Average number of weekend day trips</td></tr>
<tr><td>f_[bus|rail|other]</td><td>Average number of daily trips by route group</td></tr>
<tr><td>f_[bus|rail|other]_wd</td><td>Average number of weekday trips by route group</td></tr>
<tr><td>f_[bus|rail|other]_we</td><td>Average number of weekend day trips by route group</td></tr>
<tr><td rowspan="5">aggregated_stop_loading.shp
** This shapefile not included for individual provider downloads **
Aggregated loading for stop groups (individual or multiple</td><td>r</td><td>Count of routes serving the stop group</td></tr>
<tr><td>r_wd</td><td>Count of routes serving the stop group on weekdays</td></tr>
<tr><td>r_we</td><td>Count of routes serving the stop group on weekend days</td></tr>
<tr><td>r_[bus|rail|other]</td><td>Count of routes serving the stop group by route group</td></tr>
<tr><td>r_wd_[bus|rail|other]</td><td>count of routes serving the stop group on weekdays, by route group</td></tr>
</table>

File	Field	Description
stops) across providers (i.e., overlapping provider stop loading data is combined), clipped to the extent specified when generating the download.	r_we_[bus|rail|other]	Count of routes serving the stop group on weekend days, by route group
	f	Average number of daily trips through the stop group (all frequencies rounded to nearest tenth)
	f_wd	Average number of weekday trips
	f_we	Average number of weekend day trips
	f_[bus|rail|other]	Average number of daily trips by route group
	f_wd_[bus|rail|other]	Average number of weekday trips by route group
	f_we_[bus|rail|other]	Average number of weekend day trips by route group

This database can be queried by creating a polygon around an area of interest. This triggers the creation of the files described above (as well as a readme file with general information on the data set, a table of all feeds included in the database and tables of detailed modes [route types]

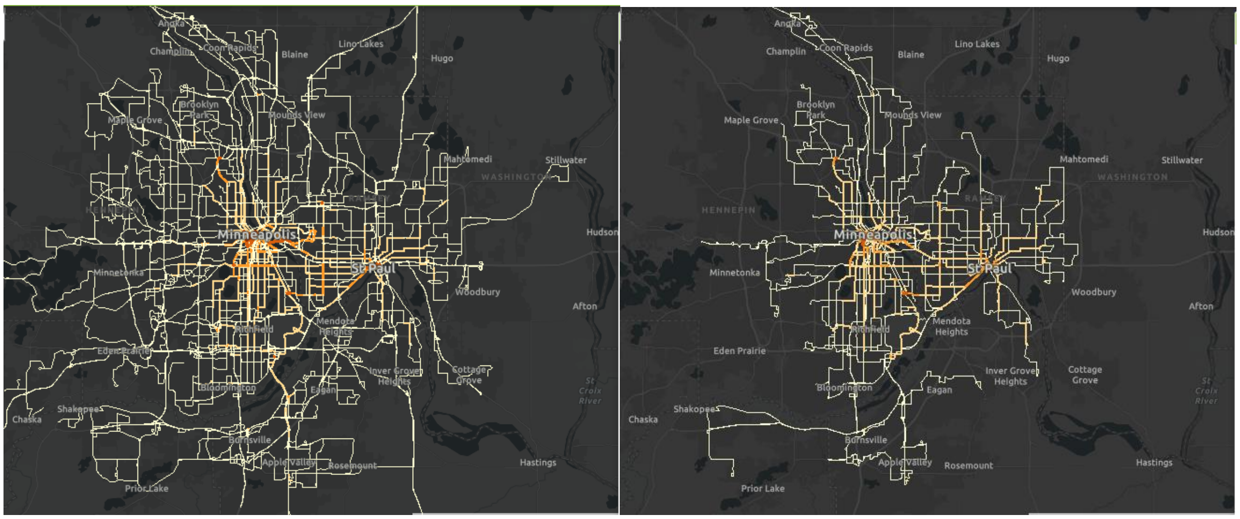

Figure 11: Comparison of weekday (left) and weekend (right) service from online mapping (Minneapolis-St. Paul).

Figure 12: Comparison of weekday (left) and weekend (right) service from online mapping (Berlin).

Figure 13: Comparison of weekday (left) and weekend (right) service from online mapping (Melbourne).

and simplified modes [route groups]) for the area selected from the underlying database and prompts the user to download them when ready. The app also allows online display of routes, segment loadings and stop loadings for weekdays and weekend days, as shown in Figures 11, 12 and 13. Thicker lines and darker colors indicate higher service frequencies.

Figure 11 shows a weekday-weekend comparison for the Twin Cities region of Minneapolis-St. Paul, Minnesota, USA. A region in the Midwestern United States which experienced most of its growth after the Second World War, the Twin Cities are characterized by a noticeable difference between an urban network that operates on weekends as well as weekdays—albeit at reduced frequency—and a commuter-focused suburban express bus system, much of which shuts down on weekends.

Figure 12 shows the same comparison for Berlin, Germany. Berlin has a mix of radial and circumferential routes. Nearly all routes appear to operate weekdays and weekends, and, while frequencies are lower on some on the weekends, even differences in frequency appear relatively small in most cases.

Figure 13 shows Melbourne, Australia. In contrast to Berlin, Melbourne has a strongly grid-based local transit system, with a mix of high frequency tram and bus routes on major corridors and lower frequency bus routes providing enhanced coverage, along with a suburban and regional railway network. Similar to Berlin, however, frequencies decline on weekends, but most routes still operate.

SAMPLE ANALYSIS

The following section briefly describes a sample analysis that can be performed using data downloaded from the app to compare transit service levels in ACP50s—or racially concentrated areas of poverty—in which more than 40% of households live on less than 185% of the Federal poverty standard and more than 50% of residents are people of color.

After downloading and extracting the transit trip frequency data as well as a polygon layer showing the areas in question (The latter can readily be obtained using census data and TIGER shapefiles for any region in the United States.), both are mapped in ArcGIS, as shown in Figure 14.

This yields a polygon layer describing the units of analysis (ACP50s), overlaid with polyline and multipoint layers describing the transit routes passing through them and the stops within them. The Spatial Join tool in ArcGIS allows the aggregation of route-level trip frequencies and individual stops to the level of ACP50s.

First, spatially join stop_loading to the polygon layer of ACP50s (as shown in Figure 15). In the field map of join features, delete all features except a unique identifier for the features of the polygon layer (in this case, ACP_Name) and stop_id. Set the merge rule for stop_id to “count”.

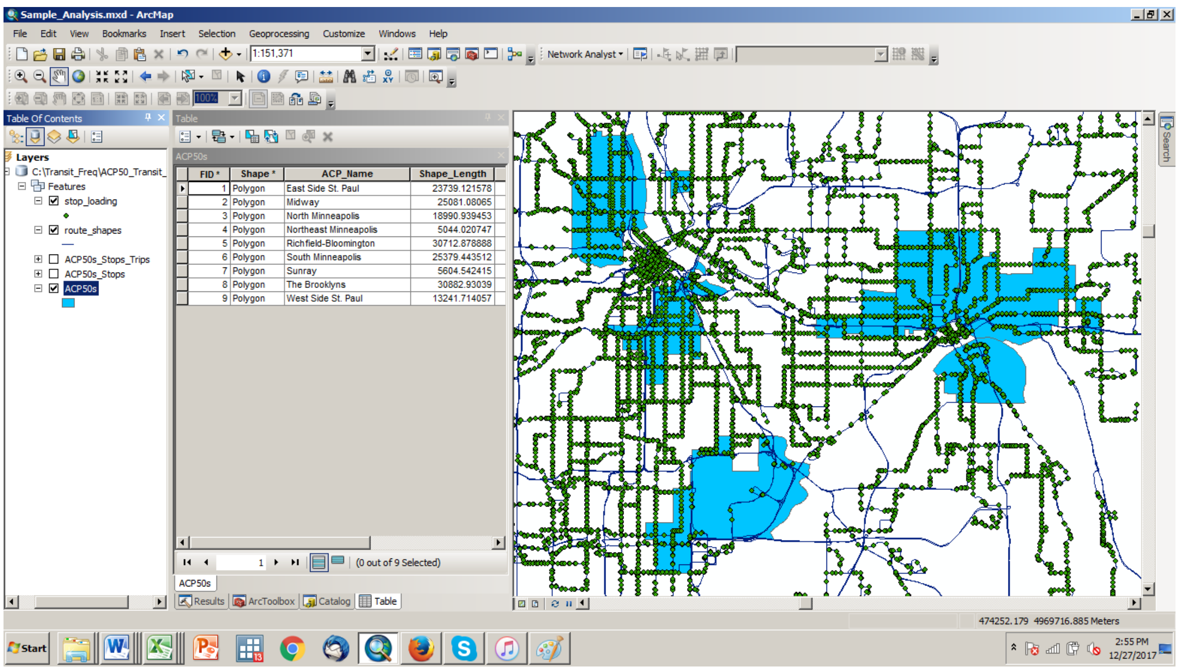

Figure 14: Input data for sample analysis

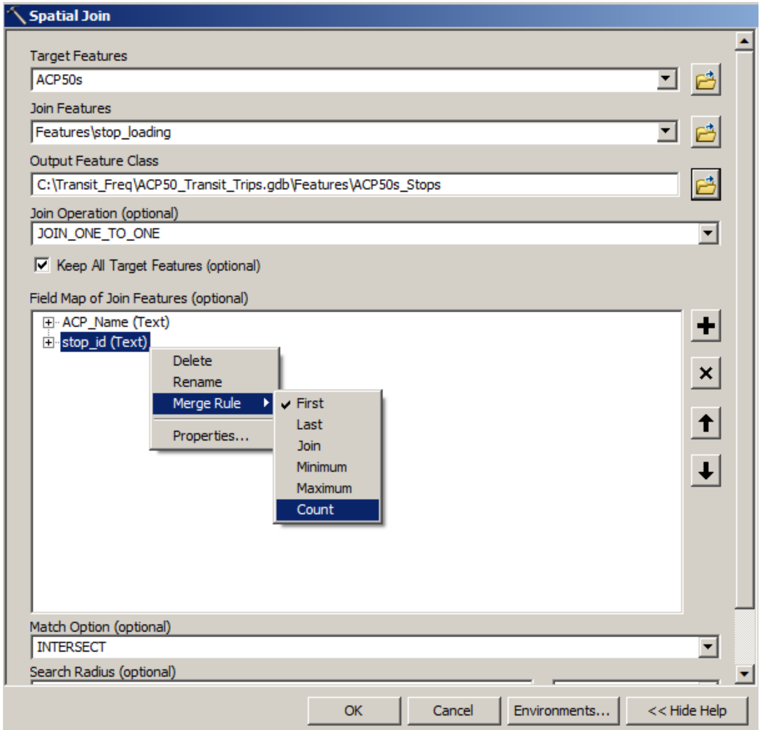

Figure 15: Spatial join of stop_loading to ACP50s

The output feature class from running this tool will be a polygon layer with a count of transit stops in each ACP50. (See Figure 16.) One more spatial join allows the addition of an aggregate count of transit trips serving each ACP50 on an average weekday.

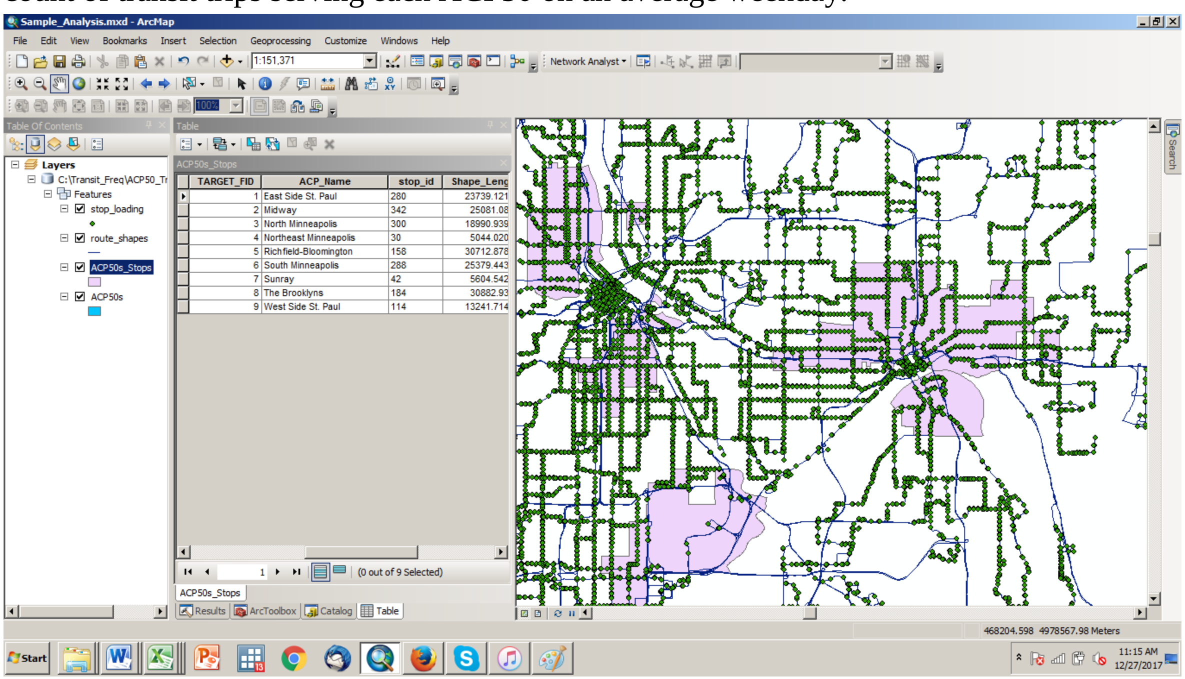

Figure 16: Output of spatial join of stop_loading to ACP50s

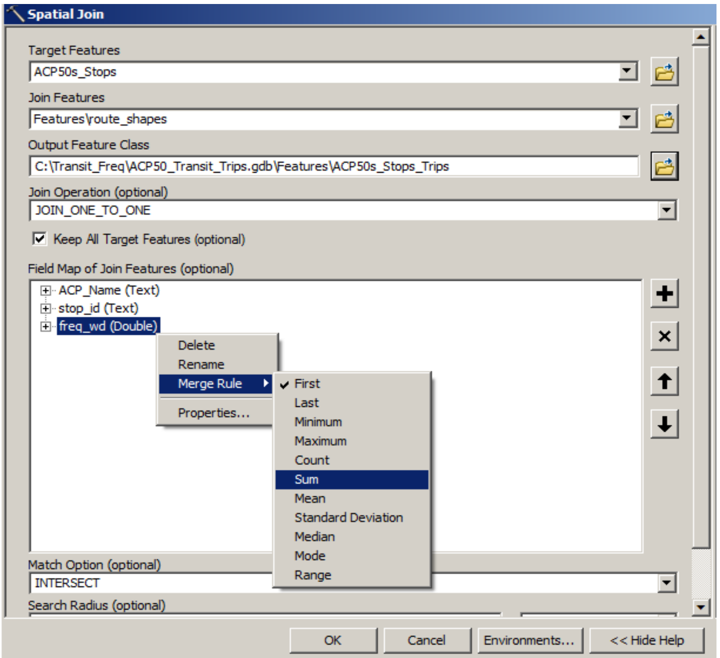

Figure 17: Spatial join of route_shapes to stop counts by ACP50

The final step in calculating our sample analysis is to spatially join route_shapes to the output of the previous spatial join, as shown in Figure 17. In the field map of join features, delete all fields except ACP_Name, stop_id (now the count of stops in each ACP50) and freq_wd (the number of trips each route operates on an average weekday). Set the merge rule for freq_wd to “sum”. The output will be a polygon layer with one feature for each ACP50 and attributes describing the total number of transit stops located in each ACP50 as well as the total number of transit trips serving each ACP50 on an average weekday, as shown in Figure 18.

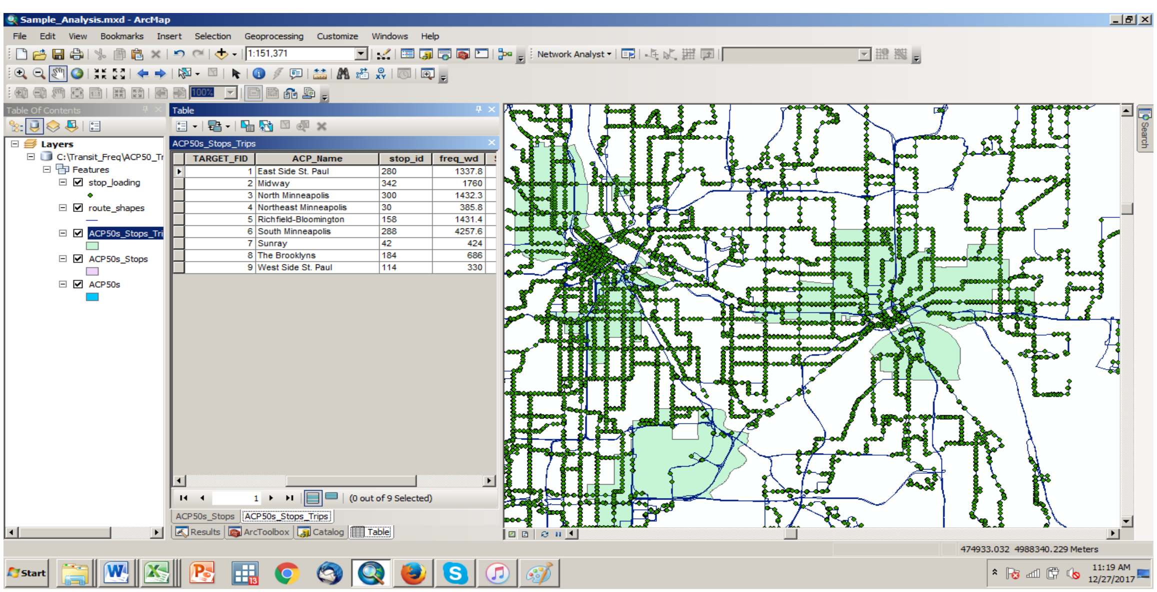

Figure 18: Output of sample analysis

The results of this analysis can be used to map the levels of transit service in ACP50s. The symbology for the layer of ACP50s can be set to display quantities of trips serving each area on an average weekday, as shown in Figure 19. In this map, we can see that transit service is by no means equal to ACP50s in the Twin Cities region, despite the fact that all of them are located in the central cities or inner suburbs. South Minneapolis has the highest level of service based on trip frequency, followed by the Midway area in Saint Paul. The range of service frequencies is wide, as well, spanning from 330 trips per weekday to 4,258.

Figure 19 considers all the trips that pass through an ACP50, regardless of its area or their length. Considering the stops in an ACP50 calls for a consideration of geographic area, however. This can be accomplished by adding double field name SqMi to the attribute table of the final ACP50 shapefile and calculating its geometry as square miles, as shown in Figure 20.

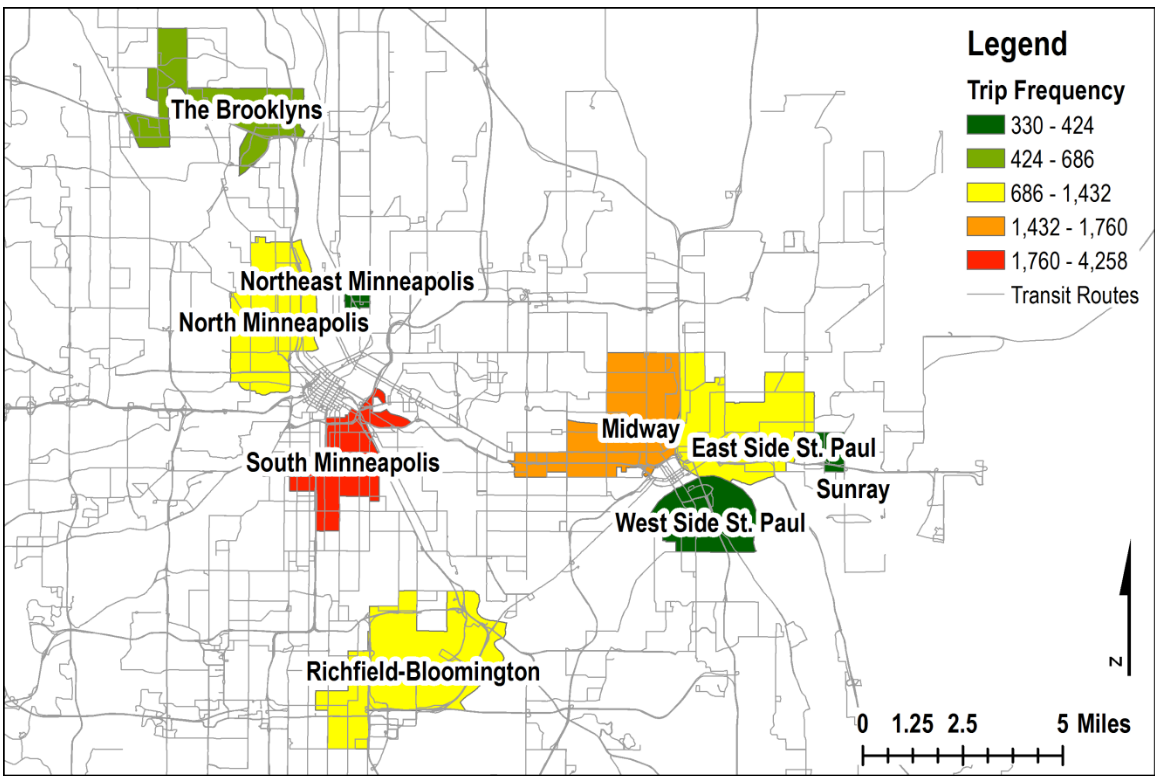

Figure 19: ACP50s by Transit Trip Frequency

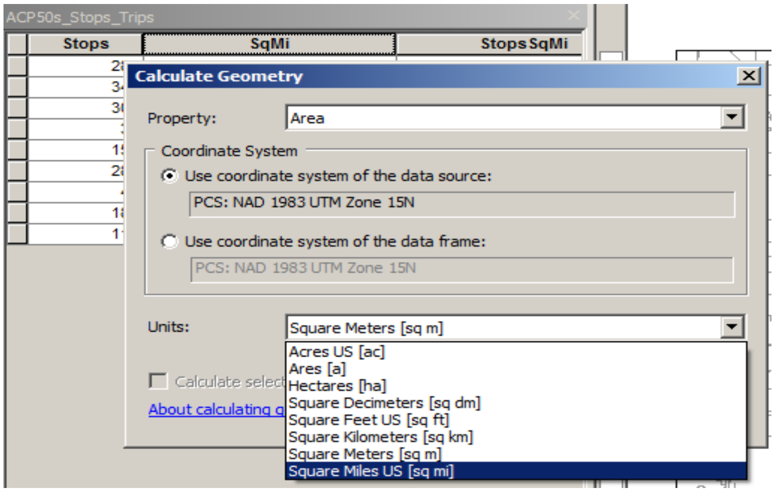

Figure 20: Calculating Geometry

This area field can then be used to calculate the number of stops per square mile in each ACP50. To do this, add a double field to the ACP50 shapefile attribute table named StopsSqMi. Use the field calculator to calculate this field as the number of stops in each ACP50 divided by the area of each ACP50 in square miles as shown in Figure 21.

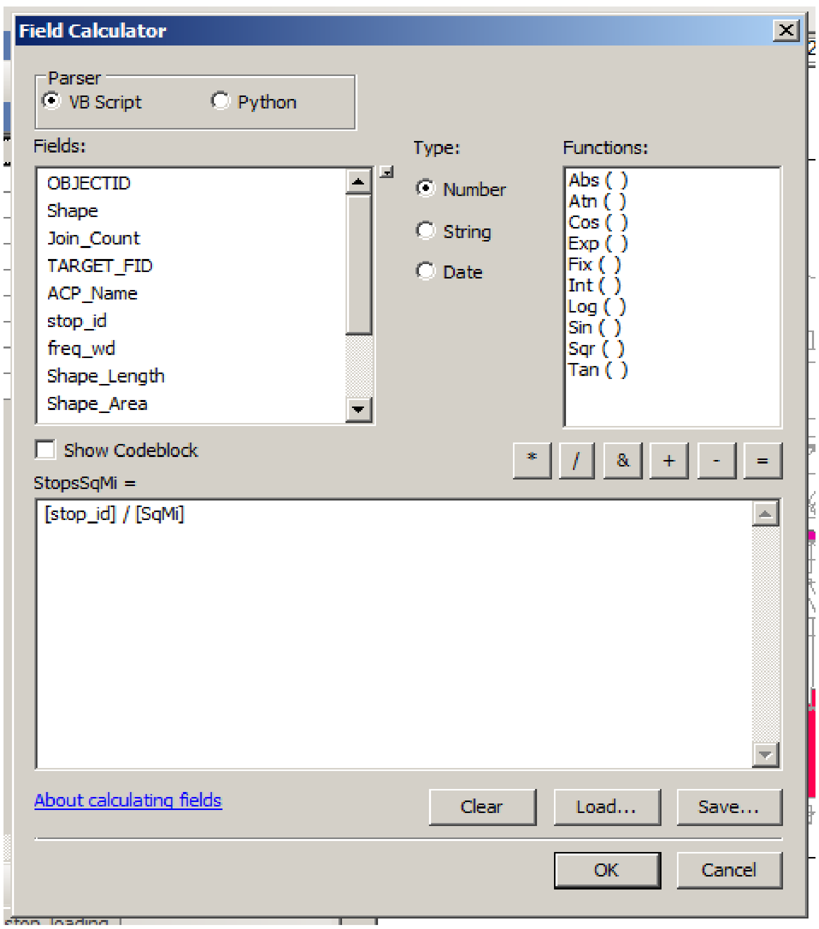

Figure 21: Calculating Stops per Square Mile

The result of this calculation can be used to map ACP50s by their stop density measured in stops per square mile, as shown in Figure 22. This map shows a different pattern from Figure 19 in one sense, with Sunray having the highest stop density—likely due to a large number of routes converging at a transit center and a small overall area. Otherwise, the general pattern of Figure 19 holds to some extent, with South Minneapolis the second densest, and Midway in the third densest category, along with North Minneapolis.

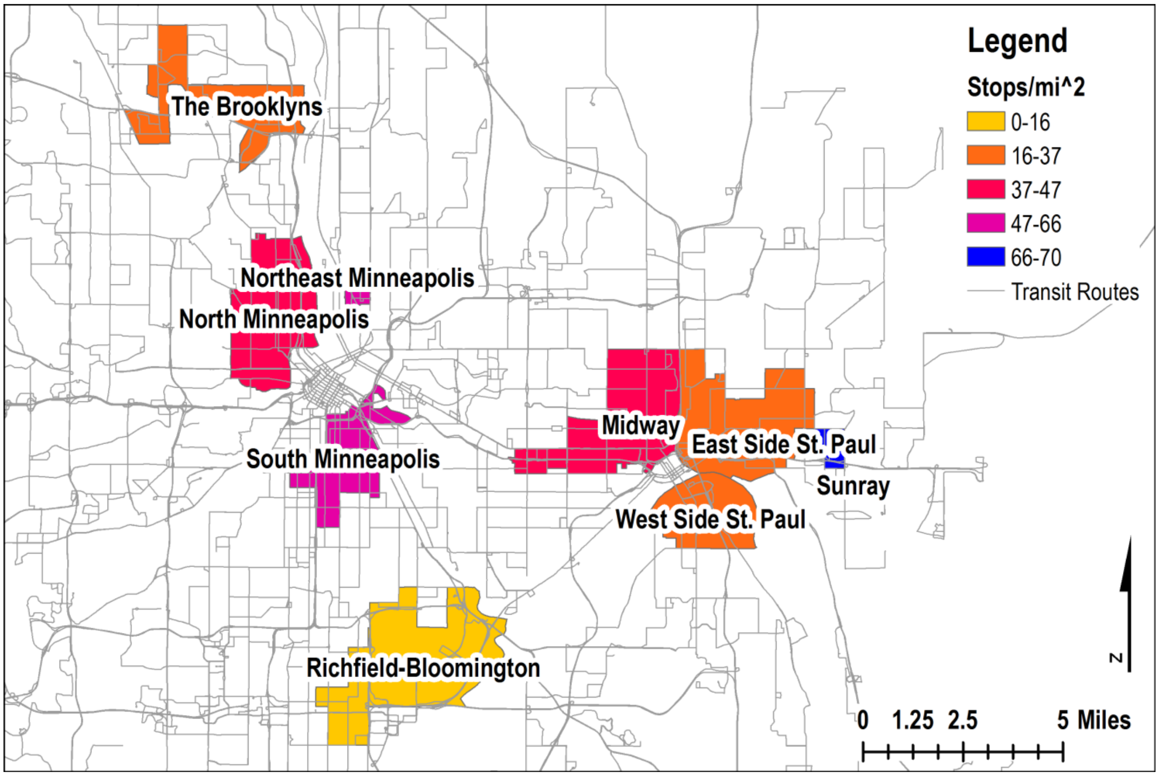

Figure 22: ACP50s by Stop Density

This section only shows a small number of the analyses possible using the data downloads provided by the Transit Service Frequency App. It is not intended to be comprehensive by any means, but to offer a relatively simple example of what is possible using the data the app provides.

CONCLUDING REMARKS

The Transit Trip Frequency App aims to create a central, convenient, standardized source of information on transit service levels that is as globally comprehensive as current data availability allows. (Appendix A shows systems included by country.) It offers a source of analysis-ready geospatial data for use by researchers, planners, transportation professionals and policy makers.

In the interest of making the same information available to a broader group of communities and stakeholders, the Transit Trip Frequency App also supports online mapping, using the ArcGIS Online platform. This allows users to directly visualize transit trip frequency in their web browser, without the need for specialized software. One of the key features of the Transit Trip Frequency App is the capability to map overall service levels, with the option to break service levels out into weekday or weekend groups. In addition to broadening access to information on transit service levels, the data the Transit Trip Frequency App offers an opportunity to broaden interest in and discussion of transit service levels provided around the world.

Country/Continent	Region/City	Feed Name
Argentina	Buenos Aires	Subte GTFS
	Córdoba	Mar Chiquita GTFS
Australia	Adelaide	Adelaide Metro GTFS
	Airlie Beach	Airlie Beach GTFS
	Alice Springs	Alice Springs GTFS
	Bowen	Bowen GTFS
	Brisbane	TransLink SEQ GTFS
	Bundaberg	Bundaberg GTFS
	Cairns	Cairns GTFS
	Canberra	Action Buses GTFS
	Darwin	Darwin GTFS
	Gladstone	Gladstone GTFS
	Gympie	Gympie GTFS
	Innisfail	Innisfail GTFS
	Kilcoy	Kilcoy GTFS
	Mackay	Mackay GTFS
	Magnetic Island	Magnetic Island Ferry GTFS
	Magnetic Island	Magnetic Island GTFS
	Maleny	Maleny / Landsborough GTFS
	Maryborough	Maryborough / Harvey Bay GTFS
	Melbourne	PTV GTFS
	Mornington Peninsula Shire	Mornington Railway GTFS
	New South Wales	Greater Sydney GTFS
	Perth	Transperth GTFS
	Rockhampton	Rockhampton GTFS
	Toowoomba	Toowoomba GTFS
	Townsville	Townsville GTFS
	Warwick	Warwick GTFS
	Yeppoon	Yeppoon GTFS
Austria	Vienna	Wiener Linien GTFS
Belgium	Brussels	STIB-MIVB GTFS
Brazil	Bagé	Prefeitura de Bage GTFS
	Belo Horizonte	BHTRANS GTFS
	Porto Alegre	EPTC GTFS
Canada	Barrie	Barrie Transit GTFS
	Brampton	Brampton Transit GTFS
	British Columbia	BC Transit GTFS
	British Columbia	Central Fraser Valley GTFS
	British Columbia	Chilliwack GTFS
	British Columbia	Comox Valley GTFS
	British Columbia	FVX GTFS
	British Columbia	Kamloops GTFS
	British Columbia	Kelowna GTFS

	British Columbia	Nanaimo GTFS
	British Columbia	Prince George GTFS
	British Columbia	Squamish GTFS
	British Columbia	Sunshine Coast GTFS
	British Columbia	Victoria GTFS
	British Columbia	Whistler GTFS
	Burlington	BURT GTFS
	Calgary	Calgary Transit GTFS
	Charlottetown	T3 Transit GTFS
	Edmonton	ETS GTFS
	Edmonton	Strathcona County Transit GTFS
	Gatineau	STO GTFS
	Guelph	Guelph Transit GTFS
	Halifax	MetroTransit GTFS
	Hamilton	Hamilton Street Railway GTFS
	Kingston	Kingston Transit GTFS
	Laval	STL GTFS
	London	LTC GTFS
	Longueuil	RTL GTFS
	Mississauga	MiWay GTFS
	Moncton	Codiac Transpo GTFS
	Montreal	AMT Express GTFS
	Montreal	AMT Trains GTFS
	Montreal	CIT Chambly-Richelieu-Carignan GTFS
	Montreal	CIT des Laurentides GTFS
	Montreal	CIT du Haut-Saint-Laurent GTFS
	Montreal	CIT La Presqu'île GTFS
	Montreal	CIT Le Richelain GTFS
	Montreal	CIT Roussillon GTFS
	Montreal	CIT Sorel-Varennes GTFS
	Montreal	CIT Sud-ouest GTFS
	Montreal	CIT Vallée-du-Richelieu GTFS
	Montreal	CRT Lanaudière GTFS
	Montreal	MRC de Deux-Montagnes GTFS
	Montreal	MRC de L'Assomption GTFS
	Montreal	MRC les Moulins GTFS
	Montreal	STM GTFS
	Montreal	Ville de Sainte-Julie GTFS
	Niagara Regional Municipality	Niagara GTFS
	Oakville	Oakville Transit GTFS
	Quebec	RTC GTFS

	Regina	The City of Regina GTFS
	Saint Albert	St Albert Transit GTFS
	Saskatoon	Saskatoon Transit GTFS
	Sherbrooke	Société de Transport de Sherbrooke GTFS
	St. John's	Metrobus Transit GTFS
	Sudbury	Greater Sudbury Transit GTFS
	Thunder Bay	Thunder Bay Transit GTFS
	Toronto	GO Transit GTFS
	Toronto	TTC GTFS
	Toronto	UP Express GTFS
	Vancouver	TransLink GTFS
	Waterloo	GRT GTFS
	Windsor	Transit Windsor GTFS
	Winnipeg	Winnipeg Transit GTFS
	York	YRT/Viva GTFS
Czech Republic	Prague	Bean Shuttle GTFS
	Prague	Praha GTFS
Estonia		Maanteeamet GTFS
Europe		FlixBus GTFS
Finland	Helsinki	HSL GTFS
	Tampere	JOLI GTFS
France	Grenoble	TAG GTFS
	Nancy	Grand Nancy GTFS
	Toulouse	Tisséo GTFS
Germany	Aachen	AAV GTFS
	Berlin	VBB GTFS
Hungary	Budapest	BKK GTFS
	Miskolc	MVK GTFS
	Pécs	BIOKOM GTFS
	Szeged	DAKK GTFS
Ireland	Dublin	Dublin Bus GTFS
Israel	Israel	Israel GTFS
Italy	Bari	Ferrotramviaria GTFS
	Bari	Ferrotramviaria GTFS
	Florence	ATAF GTFS
	Marche	Marche GTFS
	Milan	AMAT GTFS
	Mugello	AMV GTFS
	Palermo	AMAT GTFS
	Rome	Mobilità GTFS
	Trento	TTE Urbano GTFS

	Turin	Gruppo Torinese Trasporti GTFS
	Turin	SFM (Railway) GTFS
	Varese	Autolinee Varesine GTFS
	Venice	Automobilistico GTFS
	Venice	Navigazione GTFS
Japan	Shizuoka Prefecture	Shimada Local Voluntary Operation Bus GTFS
	Yamanashi Prefecture	Yamanashi GTFS
Kenya	Nairobi	Digital Matatus GTFS
Latvia	Rīga	Rīgas Satiksme GTFS
Lithuania	Druskininkai	Kautra GTFS
	Kaunas	KVT GTFS
	Klaipėda	Klaipėda Transport GTFS
	Panevėžys	Panevezio Autobusu Parkas GTFS
	Vilnius	Vilnius Transport GTFS
Mexico	Mexico City	Mexico City GTFS
New Zealand	Auckland	Auckland Transport GTFS
	Christchurch	Metro GTFS
Norway	Rogaland	Kolumbus GTFS
Philippines	Philippines	Philippines GTFS
Poland	Szczecin	ZDiTM GTFS
	Warsaw	Komunikacja Miejska ?omianki GTFS
	Warsaw	Metro Warszawskie GTFS
	Warsaw	Warszawska Kolej Dojazdowa GTFS
	Warsaw	ZTM Warszawa GTFS
Spain	Andalusia	EMT GTFS
	Bilbao	Bizkaibus GTFS
	Madrid	EMT GTFS
	Madrid	Metro de Madrid GTFS
	Madrid	Metro Ligero de Madrid GTFS
	Pamplona	TCC GTFS
	San Sebastián	dBus GTFS
	Valencia	EMT GTFS
	Vitoria-Gasteiz	Tuvisa-EuskoTran GTFS
Thailand	Chiang Mai	CMU GTFS
	Chiang Mai	Coopthai GTFS
	Chiang Mai	GreenBus GTFS
	Chiang Mai	Kwanwian Transport GTFS
	Chiang Mai	LPT GTFS
	Chiang Mai	Northern Chiang Mai GTFS
	Chiang Mai	Western Chiang Mai GTFS
	Chiang Mai	Western Chiang Mai GTFS

	Chiang Mai	WhiteBus GTFS
The Netherlands		OVapi GTFS
UK	London	Smartbus GTFS
USA	Addison County	ACTR GTFS
	Albany	Albany Transit System GTFS
	Albany	CDTA GTFS
	Albany	Linn-Benton Loop Bus GTFS
	Albuquerque	ABQ Ride GTFS
	Alexandria	DASH Bus GTFS
	Allegany	Allegany County Transit GTFS
	Allentown	LANTA GTFS
	Amador County	Amador Transit GTFS
	Anaheim	ART GTFS
	Anchorage	People Mover GTFS
	Ann Arbor	TheRide GTFS
	Ann Arbor	University of Michigan Transit Services GTFS
	Annapolis	Annapolis Transit GTFS
	Arlington	ART GTFS
	Asheville	Asheville Transit Service GTFS
	Astoria	NorthWest POINT GTFS
	Astoria	SETD GTFS
	Athens	Athens Public Transit GTFS
	Atlanta	Atlanta Streetcar GTFS
	Atlanta	GRTA GTFS
	Atlanta	MARTA GTFS
	Attleboro	GATRA GTFS
	Austin	Capital Metro GTFS
	Bakersfield	Airport Valet Express GTFS
	Bakersfield	GET GTFS
	Bakersfield	Kern Transit GTFS
	Baltimore	BWI Airport Shuttle GTFS
	Beaumont	PASS Transit GTFS
	Beloit	Beloit Transit GTFS
	Bend	Central Oregon Breeze GTFS
	Bend	CET GTFS
	Bennington	GMCN GTFS
	Benton County	Benton County Transportation GTFS
	Berkshire	Berkshire RTA GTFS
	Big Bear	Mountain Transit GTFS
	Birmingham	BJCTA MAX GTFS
	Bishop	Eastern Sierra Transit GTFS

	Blacksburg	Blacksburg Transit GTFS
	Bloomington	Bloomington Transit GTFS
	Bloomington	Connect Transit GTFS
	Boise	VRT GTFS
	Boston	Boston Harbor Islands Ferries GTFS
	Boston	MBTA GTFS
	Bozeman	Streamline GTFS
	Bradenton	MCAT GTFS
	Brecksville	Cuyahoga Valley Scenic Railroad GTFS
	Bremerton	Kitsap Transit GTFS
	Brockton	Brockton Area Transit Authority RTA GTFS
	Bronx	MTA Bronx GTFS
	Brookings	CPT GTFS
	Brookings	SouthWest POINT GTFS
	Brooklyn	MTA Brooklyn GTFS
	Brooksville	TheBus GTFS
	Buffalo	NFTA GTFS
	Bullhead City	Bullhead Area Transit System GTFS
	Butte	Butte Bus GTFS
	Cabarrus County	Rider Transit GTFS
	Canby	CAT GTFS
	Cape Cod	Cape Cod RTA GTFS
	Carroll County	CATS GTFS
	Cary	GoCary GTFS
	Cecil County	Cecil Transit GTFS
	Chapel Hill	CHT GTFS
	Charleston	CARTA GTFS
	Chattanooga	CARTA GTFS
	Chesterton	South Shore Line GTFS
	Chicago	CTA GTFS
	Chicago	Metra GTFS
	Chittenden County	CCTA GTFS
	Cincinnati	Cincinnati Metro GTFS
	Citrus County	Citrus County Transit GTFS
	Clackamas County	CCC Xpress GTFS
	Clackamas County	South Clackamas Transportation District GTFS
	Clemson	CAT Bus Transit
	Cleveland	GCRTA GTFS
	Cobb County	CCT GTFS
	Colorado	Rocky Mountain National Park Shuttles GTFS
	Columbia County	CC Rider GTFS

	Columbus	COTA GTFS
	Coos County	CCAT GTFS
	Corona	Corona Cruiser GTFS
	Corpus Christi	CCRTA GTFS
	Corvallis	Corvallis Transit System GTFS
	Cottage Grove	South Lane Wheels GTFS
	Cottonwood	CAT GTFS
	Cottonwood	Verde Lynx GTFS
	Crescent City	RCT GTFS
	Cumberland County	Lakes Region Explorer GTFS
	Dallas	DART GTFS
	Dallas County	STAR Transit GTFS
	Davis	Unitrans GTFS Feed
	Delaware	DART GTFS
	Denver	Bustang GTFS
	Denver	RTD Denver GTFS
	Des Moines	DART GTFS
	Detroit	Detroit DOT GTFS
	Duarte	Duarte Transit GTFS
	Duluth	Duluth Transit GTFS
	Durham	Duke University GTFS
	Durham	GoDurham GTFS
	Durham	GoTriangle GTFS
	Eagle County	ECO Transit
	El Dorado County	El Dorado Transit GTFS
	El Paso	Sun Metro GTFS
	Emeryville	Emery Go-Round GTFS
	Escalon	eTrans GTFS
	Eugene	Cascade POINT GTFS
	Eugene	City 2 City Shuttle GTFS
	Eugene	Eugene to Bend GTFS
	Eugene	Eugene to Coos Bay
	Everett	Community Transit GTFS
	Everett	Everett Transit GTFS
	Fairbanks	MACS Transit GTFS
	Fairfax	Fairfax Connector GTFS
	Fairfield	FAST Transit GTFS
	Fargo	MATBUS GTFS
	Farmington	Red Apple Transit GTFS
	Flagstaff	Mountain Line GTFS
	Florence	Rhody Express GTFS

	Fort Collins	Transfort GTFS
	Fort Lauderdale	Broward County Transit GTFS
	Fort Wayne	Citilink GTFS
	Fort Worth	FWTA GTFS
	Fort Wright	TANK GTFS
	Fresno	FAX GTFS
	Fresno	FCRTA GTFS
	Gainesville	Gainesville RTS GTFS
	Grand Forks	Cities Area Transit GTFS
	Grant County	People Mover GTFS
	Greensboro	PART GTFS
	Gwinnett County	Gwinnett County Transit GTFS
	Hampton	HRT GTFS
	Harford County	Harford Transit LINK GTFS
	Harrisonburg	HDPT GTFS
	Hartford	Advance Transit GTFS
	Hartford	CT Transit Hartford GTFS
	Hesperia	VVTA GTFS
	Honolulu	TheBus GTFS
	Hood River County	CAT GTFS
	Houston	METRO Houston GTFS
	Humboldt County	Humboldt County GTFS
	Huntsville	Huntsville Shuttle GTFS
	Indianapolis	IndyGo GTFS
	Jackson	JATRAN GTFS
	Janesville	Janesville Transit System GTFS
	Jefferson County	JeffCo Express GTFS
	Jersey City	PATH GTFS
	Johnson County	The JO GTFS
	Josephine County	JCT GTFS
	Juneau	Capital Transit GTFS
	Kansas City	KCATA GTFS
	Ketchum	MRTA GTFS
	Klamath Falls	BTS GTFS
	Klamath Falls	Klamath Shuttle GTFS
	Klamath Falls	Quail Trail Public Transit GTFS
	La Grande	Neotransit GTFS
	Laguna Beach	LBT GTFS
	Lansing	CATA GTFS
	Las Vegas	RTC Southern Nevada GTFS
	Laurel	CMRT GTFS

	Lexington	Lextran GTFS
	Lincoln	StarTran GTFS
	Lincoln County	LCT GTFS
	Linn County	Linn Shuttle GTFS
	Little Rock	CATA GTFS
	Livermore	Wheels GTFS
	Lodi	GrapeLine GTFS
	Long Beach	LBT GTFS
	Long Island	Long Island Rail Road GTFS
	Longview	RCT GTFS
	Los Angeles	LA Metro Bus GTFS
	Los Angeles	LA Metro Rail GTFS
	Los Angeles	LADOT GTFS Feed
	Lowell	Lowell RTA GTFS
	Lower Lake	LTA GTFS
	Lynchburg	Greater Lynchburg Transit Co. GTFS
	Madera	Madera County Transit GTFS
	Madison	Metro Transit GTFS
	Malheur County	Malheur Council on Aging & Community Services GTFS
	Manatee County	MCAT GTFS
	Marin County	Marin Transit GTFS
	Maryland	MTA Maryland GTFS
	Maryland	RTA Maryland
	Mason County	Mason Transit GTFS
	Massachusetts	Bay State Cruise Company GTFS
	Massachusetts	Block Island Ferry GTFS
	Massachusetts	Bloom Tours GTFS
	Massachusetts	Cape Ann RTA GTFS
	Massachusetts	Coach Bus Lines GTFS
	Massachusetts	Cuttyhunk Ferry Company GTFS
	Massachusetts	DATTCO Motorcoach GTFS
	Massachusetts	Freedom Cruise Line GTFS
	Massachusetts	Hy-Line Cruises GTFS
	Massachusetts	Martha's Vineyard Transit Authority GTFS
	Massachusetts	Merrimack Valley RTA GTFS
	Massachusetts	Montachusett RTA GTFS
	Massachusetts	Patriots Party Boats GTFS
	Massachusetts	PVTA GTFS
	Massachusetts	Seastreak Ferry GTFS
	Massachusetts	SRTA GTFS
	Massachusetts	Vineyard Fast Ferry GTFS

	Massachusetts	VTA GTFS
	Massachusetts	Yankee Line GTFS
	Medford	RVTD GTFS
	Melbourne	SCAT GTFS
	Mendocino	Mendocino Transit Authority GTFS
	Mendocino County	MTA GTFS
	Merced	The Bus GTFS
	Meriden	CT Transit Meriden GTFS
	Miami	MDC Transit GTFS
	Middlesex County	9 Town Transit GTFS
	Milton-Freewater	City of Milton-Freewater Public Transportation GTFS
	Milwaukee	MCTS GTFS
	Minneapolis	Metro Transit GTFS
	Minneapolis	MVTA GTFS
	Missoula	Mountain Line GTFS
	Missoula	UDASH GTFS
	Modesto	MAX GTFS
	Modoc County	Sage Stage GTFS
	Monroe County	MCTA GTFS
	Monterey	MST GTFS
	Monterey Park	Spirit Bus GTFS
	Montgomery	Montgomery Transit GTFS
	Montgomery	Ride On GTFS
	Mountain View	MVgo GTFS
	Nantucket	Nantucket RTA GTFS
	Nashville	Nashville MTA GTFS
	Nassau	NICE GTFS
	Nevada County	Gold Country Stage GTFS
	New Britain	CT Transit New Britain GTFS
	New Haven	CT Transit New Haven GTFS
	New Jersey	NJ Transit Bus GTFS
	New Jersey	NJ Transit Rail GTFS
	New Orleans	NORTA GTFS
	New York	Centro GTFS
	New York	Metro-North Railroad GTFS
	New York	MTA Manhattan GTFS
	New York	NYC Bus Company GTFS
	New York	NYC Subway GTFS
	New York	NYC Subway Supplemented GTFS
	New York	Staten Island Ferry GTFS
	Newport	VRB GTFS

	Norwalk	NTS GTFS
	Oakland	AC Transit GTFS
	Oakland	Capitol Corridor GTFS
	Oakridge	Diamond Express GTFS
	Ocala	SunTran GTFS
	Ocean City	Ocean City Transportation GTFS
	Okaloosa County	Emerald Coast Rider GTFS
	Oklahoma City	Embark GTFS
	Olympia	Intercity Transit GTFS
	Ontario	Eastern Point GTFS
	Orange County	OCTA GTFS
	Orange County	STS GTFS
	Orlando	LYNX GTFS
	Orlando	SunRail GTFS
	Oshkosh	GO Transit GTFS
	Pacific County	Pacific Transit GTFS
	Painesville Township	Laketran GTFS
	Palo Verde Valley	Palo Verde Valley Transit Agency GTFS
	Palos Verdes Peninsula	PVPTA GTFS
	Panama City	Bay Town Trolley GTFS
	Pendleton	Kayak Transit / CTUIR GTFS
	Pensacola	ECAT GTFS
	Petaluma	Petaluma Transit GTFS
	Philadelphia	SEPTA Bus GTFS
	Philadelphia	SEPTA Rail GTFS
	Phoenix	Valley Metro GTFS
	Pierce County	Pierce Transit GTFS
	Pinellas	PSTA GTFS
	Pinole	WestCAT GTFS
	Pittsburgh	Port Authority GTFS
	Placer County	TART GTFS
	Plumas County	Plumas Transit GTFS
	Pompano Beach	Tri-Rail GTFS
	Portland	Blue Star GTFS
	Portland	Caravan Airport Transportation GTFS
	Portland	HUT Airport Shuttle GTFS
	Portland	Ride Connection GTFS
	Portland	Swan Island Evening Shuttle GTFS
	Portland	TriMet GTFS
	Portland	Washington Park Shuttle GTFS
	Providence	RIPTA GTFS

	Pulaski	PAT GTFS
	Queen Anne's County	County Ride GTFS
	Queens	MTA Queens GTFS
	Racine	Belle Urban System GTFS
	Radford	Radford Transit GTFS
	Raleigh	GoRaleigh GTFS
	Raleigh	NCSU GTFS
	Redding	RABA GTFS
	Redmond	High Desert Point GTFS
	Reno	RTC Washoe GTFS
	Rio Vista	Rio Vista Delta Breeze GTFS
	Roanoke	Valley Metro GTFS
	Rochester	RGRTA GTFS
	Rochester	Rochester City Lines GTFS
	Rocky Mount	Tar River Transit GTFS
	Roseburg	UTrans GTFS
	Rutland	MVRTD GTFS
	Sacramento	SACRT GTFS
	Saint Augustine	Sunshine Bus Company GTFS
	Saint Louis	Metro Transit GTFS
	Salem	Cherriots GTFS
	Salt Lake City	UTA GTFS
	San Andreas	Calaveras Transit GTFS
	San Antonio	VIA GTFS
	San Benito County	SBCE GTFS
	San Bernardino	OmniTrans GTFS
	San Diego	NCTD GTFS
	San Diego	SDMTS GTFS
	San Francisco	BART GTFS
	San Francisco	Blue & Gold Fleet GTFS
	San Francisco	Caltrain GTFS
	San Francisco	Golden Gate Transit GTFS
	San Francisco	Muni GTFS
	San Francisco	SamTrans GTFS
	San Francisco	San Francisco Bay Ferries GTFS
	San Francisco	Tideline Water Taxi GTFS
	San Gabriel Valley	Foothill Transit GTFS
	San Jose	VTA GTFS
	San Luis Obispo	City of San Luis Obispo GTFS
	San Luis Obispo	San Luis Obispo RTA GTFS
	Sandy	Mt Hood Express GTFS

	Sandy	SAM GTFS
	Santa Cruz	SCMTD GTFS
	Santa Maria	Santa Maria Area Transit GTFS
	Santa Monica	Big Blue Bus GTFS
	Seattle	Amazon SLU Shuttle
	Seattle	King County Metro GTFS
	Seattle	Sound Transit GTFS
	Seattle	The Victoria Clipper GTFS
	Seattle	Washington State Ferries GTFS
	Sedona	RoadRunner GTFS
	Sioux Falls	SAM GTFS
	Siskiyou County	STAGE GTFS
	Sitka	RIDE Sitka GTFS
	Skamania County	Skamania County Public Transit GTFS
	Solano County	SolTrans GTFS
	Sonoma County	SCT GTFS
	Spokane	STA GTFS
	Springfield	SMTD GTFS
	Stamford	CT Transit Stamford GTFS
	Stanford	SMS GTFS
	Stanislaus County	StaRT GTFS
	State College	CATA GTFS
	Staten Island	MTA Staten Island GTFS
	Stockton	San Joaquin RTD GTFS
	Susanville	LRB GTFS
	Tallahassee	StarMetro GTFS
	Tampa	HART GTFS
	Tehama County	TRAX GTFS
	Terre Haute	Terre Haute Transit GTFS
	Thousand Oaks	Thousand Oaks Transit GTFS
	Thousand Palms	SunLine Transit Agency GTFS
	Tillamook	The Wave GTFS
	Torrance	Torrance Transit GTFS
	Town of Rockingham	The Current GTFS
	Trinity County	Trinity Transit GTFS
	Tucson	SunTran GTFS
	Tulsa	Tulsa Transit GTFS
	Utah	Elevated Transit GTFS
	Ventura County	Ventura County Transportation Commission GTFS
	Vermont	GMTA GTFS
	Vermont	RCT GTFS

	Vermont	Vermont Translines GTFS
	Virginia	VRE GTFS
	Wallowa County	WCC GTFS
	Waltham	128 Business Council GTFS
	Washington	DC Circulator GTFS
	Washington	DC Streetcar GTFS
	Washington	WMATA GTFS
	Waterbury	CT Transit Waterbury GTFS
	Waukesha	Waukesha Metro Transit GTFS
	Wenatchee	Link Transit GTFS
	West Palm Beach	Palm Tran GTFS
	Westchester County	WCDOT GTFS
	Wilmington	MOOver GTFS
	Wilsonville	SMART GTFS
	Woodbridge	PRTC GTFS
	Woodburn	WTS GTFS
	Worcester	WRTA GTFS
	Yakima	Union Gap GTFS
	Yakima	Yakima Transit
	Yamhill County	YCTA GTFS
	York	Rabbit Transit GTFS
	Yosemite Valley	YARTS GTFS
	Yuba City	Yuba-Sutter Transit GTFS
	Yuma	YCIPTA GTFS

APPENDIX A: SYSTEMS INCLUDED IN THE TRANSIT TRIP FREQUENCY APP