



Module 14 Part 1: Applying General Transit Feed Specification (GTFS) to Your Agency

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1. Module Description

Module 14 Part 1 covers static GTFS data such as, schedule, bus stops, station and terminus information, and general fare policy data commonly utilized by transit agencies. Module 14-Part 1 provides an overview of GTFS and training about the structure and content of GTFS. Transit agency staff and their consultants will learn about how they can begin deploying the GTFS specification. The module will discuss the data content, data management, tools to implement the specification, and several case studies of agencies that generate and use the data specification. Additionally, the module will discuss how GTFS feeds can be used by third party developers, planners, and other users.

2. Introduction/Purpose

The General Transit Feed Specification (GTFS) defines a common format for public transportation schedules and associated geographic information that is “open,” available, and widely adopted by transit agencies. GTFS "feeds" allow public transit agencies to publish their transit data and developers to write applications that consume that data in an interoperable way. GTFS is also a key component of a Traveler Information System (TIS). Module 14-Part 1 covers static GTFS data: schedule, stop, station and terminus information, and general fare policy data commonly utilized by transit agencies. Module 14-Part 1 provides an overview of GTFS and training about the structure and content of GTFS.

3. Samples/Examples

3.1.1. Procurement Language

As a follow-up to the discussion of procurement language in Learning Objective #4, samples of procurement language are shown here. These are functional requirements, which would be developed as part of a systems engineering process. They are grouped into scenarios where they might be included. This is not an exhaustive list of all possible procurement language. In order to minimize conflict with the procurement policies and procedures of specific agencies, the procurement language examples shown are hypothetical and not taken from an actual procurement.

3.1.2. Scenario 1: Scheduling Software Export

These procurement requirements describe a scenario where an agency is seeking the ability to procure a scheduling system that has the capability of exporting GTFS feeds.

- The system shall export GTFS feeds which at minimum includes the following files: agency.txt, stops.txt, routes.txt, trips.txt, stop_times.txt, calendar.txt, calendar_dates.txt, shapes.txt, fare_attributes.txt, and fare_rules.txt.
- The system shall only export GTFS feeds which conform to the requirements of the GTFS specification.
- The system shall verify that the GTFS feed conforms to the requirements of the GTFS specification prior to finalizing export.
- The system shall only export GTFS feed which is accurate and matches the data contained in the scheduling software.

3.1.3. Scenario 2: Consultant Responsible for GTFS Production

This scenario describes the procurement of services where a consultant is responsible for producing GTFS for an agency.

- The consultant shall update the agency's GTFS quarterly as the agency's schedule changes.
- The consultant shall provide the following GTFS files: agency.txt, stops.txt, routes.txt, trips.txt, stop_times.txt, calendar.txt, calendar_dates.txt, shapes.txt, fare_attributes.txt, fare_rules.txt, and feed_info.txt
- The consultant shall perform quality control testing to ensure that 1) the GTFS feed conforms to the requirements of the GTFS specification and 2) the GTFS feed accurately shows the agency's schedule and other data.
- The consultant shall provide documentation of all testing performed.
- The consultant shall provide the GTFS feed within 2 weeks of being provided the agency's service schedule.

3.1.4. Scenario 3: Procuring Software to Create GTFS (not part of scheduling system)

This scenario describes the procurement of software to produce GTFS. This is not part of a scheduling system, and would require a user (presumably at the agency) to perform manual data entry to create GTFS.

- The software shall allow the user to select the locations of each stop and to enter optional fields required in stops.txt.
- The software shall allow the user to create patterns for each route.
- The software shall allow the user to create shapes for each pattern.
- The software shall allow the user to input stop times for each pattern in a timetable format.
- The software shall allow the user to specify the service calendar and exceptions to the service calendar.

- The software shall allow the user to input agency contact information.
- The software shall only export GTFS which meets the requirements of the GTFS specification.
- The software shall verify that the requirements of the GTFS specification are met prior to finalizing export.
- The software shall provide a mechanism for a user to verify the accuracy of data which has been manually input.

3.1.5. Scenario 4: Extensions

This scenario describes procurement of software that can produce an extension to GTFS. An example of this extension is shown in section 3.4 of the student supplement.

- The software shall collect parking information from an agency's parking lot database.
- The software shall export a custom GTFS file called "parking.txt" which includes the following fields:
 - Lot_id: required, identifier for the lot
 - Stop_id: required, stop_id (from stops.txt) that the lot is closest to
 - Open_time: optional, the time the lot opens
 - Close_time: optional, the time the lot closes
 - Parking_cost: optional, the cost to park in the lot
 - Spaces_available: optional, the number of parking spaces the lot has available
 - Lot_description: optional, Notes about the parking lot
- The software shall integrate parking.txt with the rest of the agency's GTFS files.
- The software shall only export a GTFS file that has been verified to conform to the requirements of the GTFS specification and the parking.txt extension
- The software shall include the ability to verify that the requirements of the GTFS specification and parking.txt are met.

3.2. GTFS FeedValidator Warnings and Errors

The official list of warnings and errors for GTFS can be found at:

<https://github.com/google/transitfeed/wiki/FeedValidatorErrorsAndWarnings>

3.3. Google's Open source Tools for GTFS

- FeedValidator (includes instructions):
<https://github.com/google/transitfeed/wiki/FeedValidator>
- Schedule_Viewer (includes instructions):
<https://github.com/google/transitfeed/wiki/ScheduleViewer>

3.4. Example of Extending the GTFS specification

The following is an example of an extension to the GTFS specification. This file is parking.txt which describes non real time parking information for the transit stops described in a GTFS feed. The meanings of the field are described in the sample procurement language in Section 3.1.4 of this student supplement.

```
lot_id,stop_id,open_time,close_time,parking_cost,spaces_available,lot_description
1,232,05:00:00,21:00:00,6.00,172,"Parking from 5AM until 11 PM at Main St. Stop"
2,142,,9.00,530,"Parking 24/7"
```

3.5. Selected Graphics from the Presentation

Map of GTFS Coverage

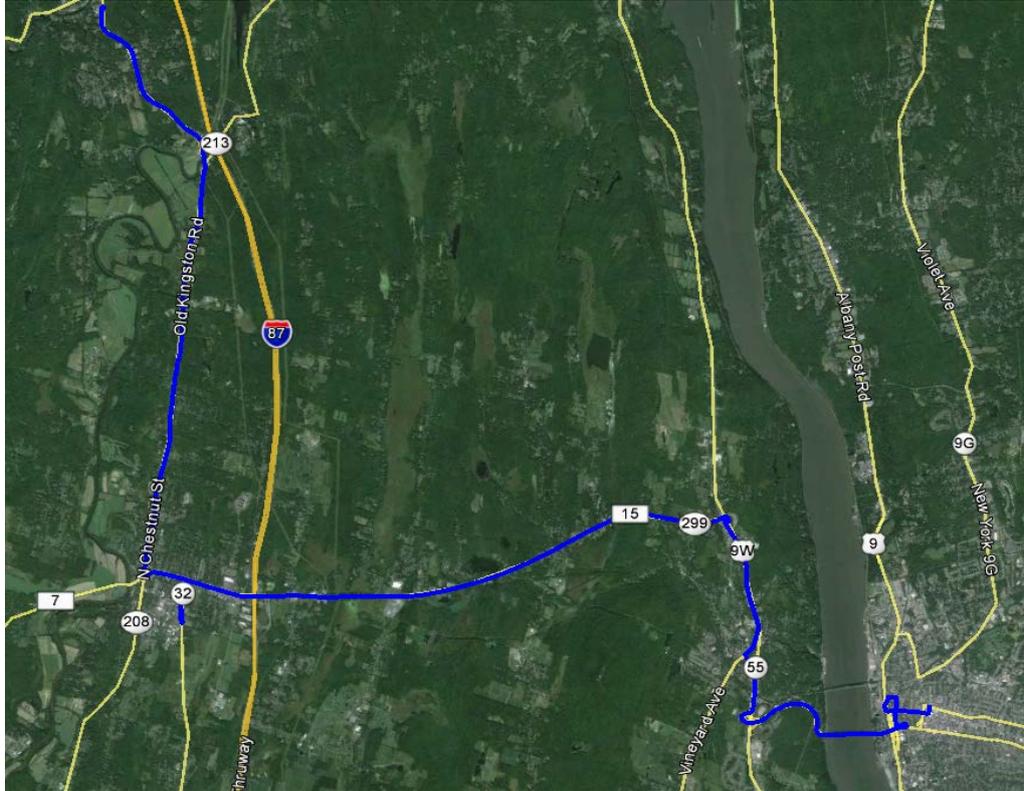
This graphic shows which countries in the world have agencies with GTFS feeds. Note that countries with dark colors have GTFS feeds, whereas countries that are lightly colored do not have GTFS feeds. Note there may be transit operators within a shaded country that do not have GTFS feeds.



Source: Google Maps

GTFS Shape on a Satellite Map

This graphic shows a shape derived from the shapes.txt GTFS file transposed onto a satellite view of a region.



Source: Ulster County Area Transit /Google Earth

National Rural Transit Assistance Program (RTAP) GTFS Builder

This graphic shows a screenshot of the Excel-based National RTAP GTFS Builder tool.

	B	C	D	E	F
Shelton to Olympia					
Wallace Kneeland		Civic Center	Red Apple - Cascade & Olympic Hwy So	Cole Road P & R @ Hwy 3	Kamille Transi Center
5:45 AM		5:50 AM	5:55 AM	6:00 AM	6:10 AM
6:15 AM		6:20 AM	6:25 AM	6:30 AM	6:40 AM
		8:10 AM	8:15 AM	8:20 AM	8:30 AM
		10:35 AM	10:40 AM	10:45 AM	10:55 AM
		12:00 PM	12:05 PM	12:10 PM	12:20 PM
		2:40 PM	2:45 PM	2:50 PM	3:00 PM
		3:40 PM	3:45 PM	3:50 PM	4:00 PM
		4:40 PM	4:45 PM	4:50 PM	5:00 PM
		5:40 PM	5:45 PM	5:50 PM	6:00 PM
		6:45 PM	6:50 PM	6:55 PM	7:05 PM

Source: National RTAP Center / U.S. DOT

Google GTFS Feed Validator Errors

This graphic shows Google’s GTFS Feed Validator tool, which is displaying a sample errors found in a feed.

ERRORS:

Invalid Value

- Invalid value 17:38:00 in field `departure_time`
 The departure time at this stop (17:38:00) is before the arrival time (21:38:00). This is often caused by problems in the feed exporter's time conversion
 in line 128 of `stop_times.txt`

trip_id	arrival_time	departure_time	stop_id	stop_sequence	stop_headsign	pickup_type	drop_off_type	shape_dist_traveled	timepoint
9157	21:38:00	17:38:00	92668	2	None	None	None	None	None

Source: Google GTFS Feed Validator

Google GTFS Feed Validator Warnings

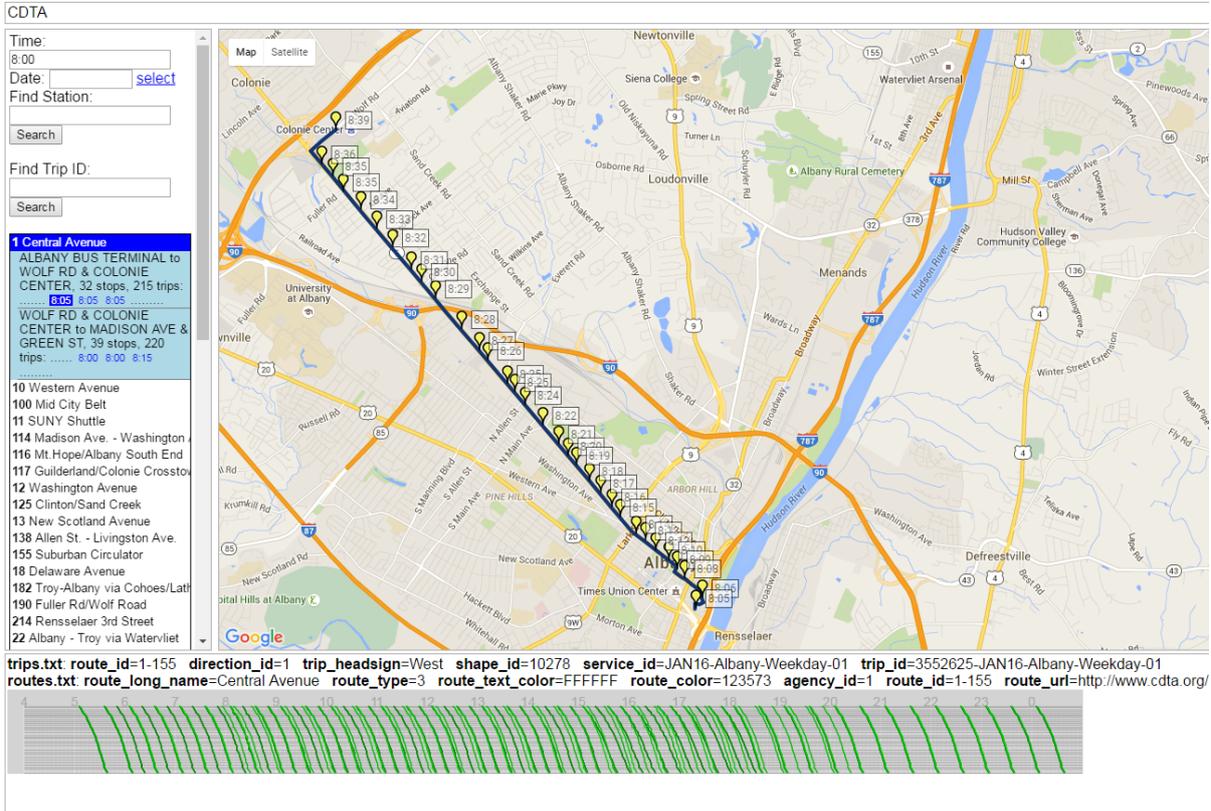
This graphic shows Google’s GTFS Feed Validator tool, which is displaying a warning found in a feed.

- High speed travel detected in trip `[@1.0.196144@][7][1418156335479]/5__7D&E-3_(WD,_SAT,_SUM): Madison Street to Madison Street. 2168 meters in 0 seconds.`

Source: Google GTFS Feed Validator

GTFS Schedule Viewer Tool

This graphic shows the Google GTFS Schedule Viewer tool, which is used to view GTFS feeds in a graphical form and is a tool to help verify the accuracy of feeds.



Source: Google GTFS Schedule Viewer

4. Case Studies

4.1. Additional Case Study- NYSDOT

The New York State Department of Transportation, also known as NYSDOT, maintains a statewide transit trip planner. The state has approximately 100 transit agencies. For more than five years, electronic transit schedules, in both GTFS id and a custom format developed by the state, have been collected and used in the 511NY Transit Trip Planner. For many years, NYSDOT has also maintained a software system that allows the manual entry of transit schedules to be included in the transit trip planner.

In 2014, NYSDOT procured a new software system which explicitly allows transit agencies to produce GTFS that can be loaded into their transit trip planner. This opens the door for agencies that do not have the resources to purchase a tool to export GTFS to still be able to provide it. The open source tool procured is GTFS Editor.

In 2015, NYSDOT sought the services of a consultant to create GTFS for transit agencies that do not have the staff resources to create their own GTFS. Approximately 60 agencies fall into this category.

The consultant is responsible for collecting schedules and other data from all of these agencies and manually entering it into the 511NY system.

As this effort has gotten underway, some challenges have appeared. One is that the information provided by agencies is not consistent. For example, while some agencies have detailed stop locations, others may refer to a local business, that must be researched to find the location. Often these businesses have closed. A second challenge is that timetables are often inconsistently formatted. This requires that a judgement to be made by the analyst inputting the data on how to represent a trip. Finally, detailed shapes are not typically available, so the analyst must make a judgement on the path that the trip shapes.

Lessons learned from this effort are: 1) ensure that all data is available, 2) ensure data is up to date, 3) have a rigorous quality control plan in place to ensure that all data entered is correct.

5. Glossary

Term	Definition
Agency Specification	A document that has been prepared by an agency to define requirements for a subject item or process when procured by the agency.
Compliance	A condition that exists when an item meets all of the requirements of an agency specification.
Concept of Operations	A document that describes the purpose for a system project, including a description of the current and proposed system, as well as key user needs that the new system is required to address.
Conformance	A condition that exists when an item meets all of the mandatory requirements as defined by a standard. It can be measured on the standard as a whole, which means that it meets all mandatory (and applicable conditional) requirements of the standard or on a feature level (i.e., it conforms to feature X as defined in section X.X.X), which means that it meets all mandatory (and applicable conditional) requirements of the feature.
Comma Separated Value (CSV)	Data files that separate fields using commas.
De Facto Standard	A specification that has not undergone a formal balloting process but implanted and used as if it were a standard.
Downstream	Describes users and tools that use data after it has been produced
Feed	Combined set of information being sent or received.
General Transit Feed Specification (GTFS)	This is a specification for creating static schedule data.
Metadata	Data which describes the feed but does not contain information being described by the feed.
Pattern	The sequencing of stops used by a transit vehicle on a trip. Is often repeated over many trips. Often includes times as well.
Rural Transit Assistance Program (RTAP)	Program sponsored by the Federal Transit Administration to fund rural transit operations.
Service Calendar	Defines the days that a trip or a set of trips operate. May describe

Term	Definition
	days of the week, specific dates. Also defines exceptions to normal service, such as for holidays.
Static information	Describes data which is consistent on a day to day basis, although it may change at a defined frequently. Refers to transit schedules.
Text File	Files that can be edit in a text editor.

6. References

GTFS Best Practices <https://maps.google.com/help/maps/mapcontent/transit/bestpractices.html>

GTFS Developers Forum: <https://groups.google.com/forum/#!forum/gtfs-changes>

GTFS Specifacaton Reference: <https://developers.google.com/transit/gtfs/reference>

National RTAP GTFS Builder: <http://nationalrtap.org/supportcenter/Builder-Apps/GTFS-Builder>

National Transit Map: http://www.rita.dot.gov/bts/press_releases/dot021_16

Transitland: <https://transit.land/>

7. Study Questions

To include the quiz/poll questions and answer choices as presented in the PowerPoint slide to allow students to either follow along with the recording or refer to the quiz at a later date in the supplement.

1. Which of the following choices best describes the process for updates to the GTFS specification?
 - a) Formal balloting process by committee
 - b) Discussion in an online forum
 - c) Voting by every transit agency
 - d) There is no process

2. Which of the following areas is NOT described by the GTFS specification?
 - a) Stop locations
 - b) Transit trip stop times
 - c) Fare information
 - d) Historical Ridership Data

3. Which of the following is NOT a tool that can be used to produce GTFS feeds?
 - a) Pencil and paper

- b) Scheduling software add-ons
 - c) National RTAP GTFS Editor
 - d) Open source software
4. Why is it important to test GTFS feeds?
- a) Ensure data is accurate and conforms to the specification
 - b) Ensure customers use trip planners
 - c) So agencies can change schedules on the fly
 - d) Because testing requires no effort
5. How should GTFS feeds be made available to downstream users?
- a) GTFS should not be made public
 - b) Written on a CD and mailed
 - c) Printed on paper
 - d) Fixed location on the web

8. Icon Guide

The following icons are used throughout the module to visually indicate the corresponding learning concept listed out below, and/or to highlight a specific point in the training material.

- 1) Background information:** General knowledge that is available elsewhere and is outside the module being presented. This will be used primarily in the beginning of slide set when reviewing information readers are expected to already know.



- 2) Tools/Applications:** An industry-specific item a person would use to accomplish a specific task, and applying that tool to fit your need.



- 3) **Refer to Student Supplement:** Items or information that are further explained/detailed in the Student Supplement.



- 4) **Example:** Can be real-world (case study), hypothetical, a sample of a table, etc.



- 5) **Checklist:** Use to indicate a process that is being laid out sequentially.

