

MBTA ROVE User Guide

Version 7.1.1

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Table of Contents

1. Introduction.....	2
2. Getting Started.....	3
2.1. Log In	3
2.2. Load Transit Data.....	4
3. Navigating the Dashboard	6
3.1. Legend Panel	6
3.2. Tool Panel.....	7
3.2.1. Controls Box	7
3.2.2. View Box.....	7
3.2.3. Filters Box.....	9
3.3. Settings Panel	10
3.4. Help Panel.....	16
3.5. Options Panel.....	16
3.5.1. Data Box.....	17
3.5.2. Import/Export Box	17
3.5.3. Preset Scenarios Box	18
3.6. The Map	19

1. Introduction

This is a user guide for the Ridership and Operations Visualization Engine (ROVE) dashboard, an interactive bus transit performance analysis tool developed by the MIT Transit Lab for the Massachusetts Bay Transportation Authority (MBTA). Its primary function is to provide instructions for new users on how to navigate the user interface and activate different ROVE features. It includes a basic discussion of the data sources and back end functions, but a more detailed review of the metric calculations, data extraction and preparation processes are included in the [ROVE Data Dictionary](#).

ROVE is intended to be a flexible and user-friendly dashboard to visualize and compare the performance of a bus network over time. It is generalizable so that it can be easily adapted to different networks. It includes performance metrics related to scheduled supply, actual supply and passenger loading, based on the data available from the agency. ROVE also allows the visualization and comparison of passenger journeys throughout the transit network. It can be used for service planning, scheduling, detour planning and many other applications. It is browser-based, and therefore does not require any special software or advanced technical knowledge on the part of the end user.

This version of the User Guide relates to Version 7.1.1, which is the current version as of July 2021. ROVE was initially developed by Rucha Mehendale and subsequently expanded by Xiaotong Guo and Nicholas Caros, all MIT Transit Lab students. John Attanucci and Anson Stewart have supervised and guided the project. Please contact Nicholas Caros (caros@mit.edu) with any questions or feedback.

2. Getting Started

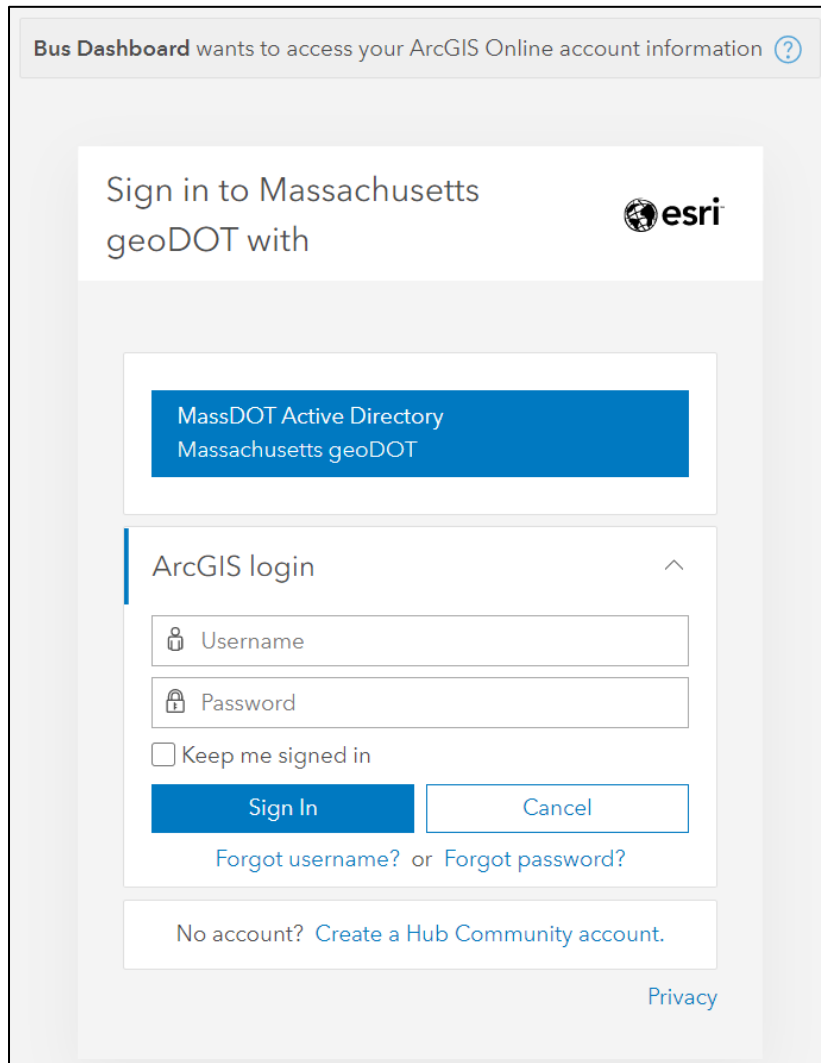
2.1. Log In

ROVE is currently hosted as a web application by the Massachusetts Department of Transportation (MassDOT) on their GeoDOT portal. It can be accessed over the internet by anyone with an authorized GeoDOT account. Google Chrome is the recommended browser for this dashboard. Please contact Nicholas Caros (caros@mit.edu) with authorization requests.


The following link provides access to the login page:

<https://gisdev.massdot.state.ma.us/busdashboard>

Once you have navigated to the link above, you will encounter the following login request:





Bus Dashboard wants to access your ArcGIS Online account information ?

Sign in to Massachusetts
geoDOT with 

MassDOT Active Directory
Massachusetts geoDOT

ArcGIS login ^

 Username

 Password

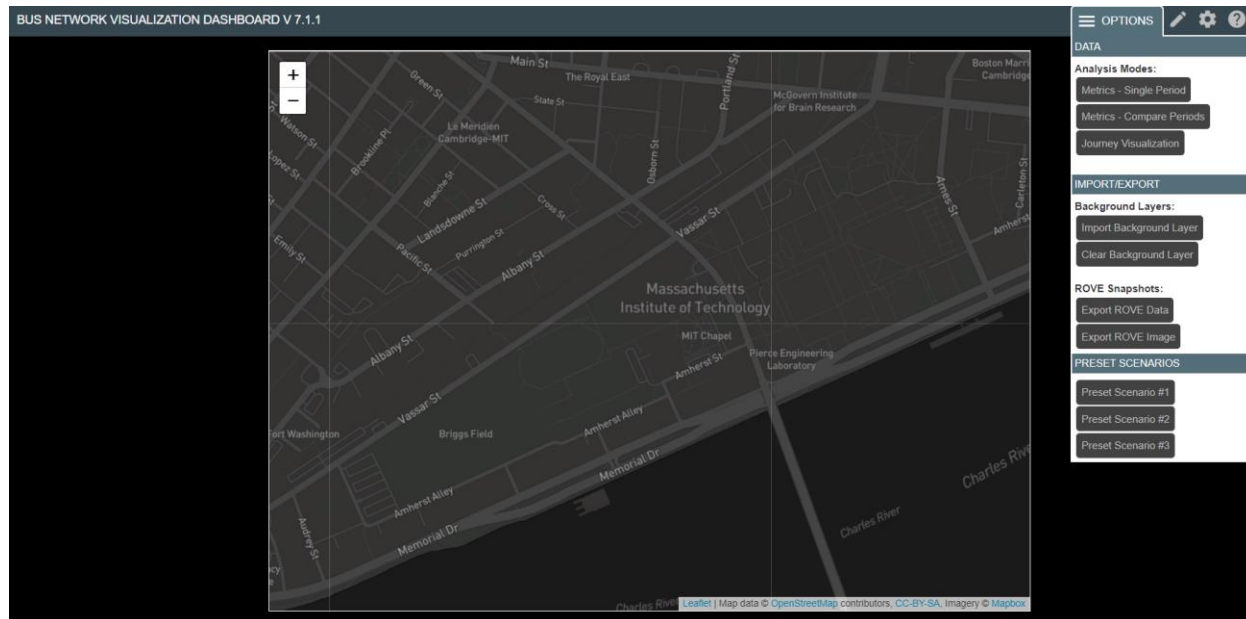
☐ Keep me signed in

[Forgot username?](#) or [Forgot password?](#)

No account? [Create a Hub Community account.](#)

[Privacy](#)

Sign in using MassDOT credentials to access the dashboard. If the login is successful, then the dashboard landing page will load:



At this point there is no transit data available, just a blank map with a toolbar on the right-hand side.

2.2. Load Transit Data

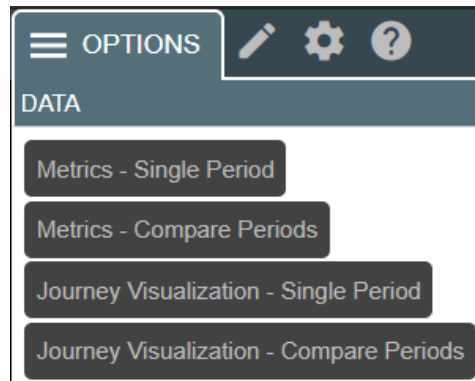
Data from different time periods can be loaded using the toolbar on the right. Typically, data is available in monthly increments. This provides a large enough sample to ensure that atypical traffic events, sensor outages, etc. do not skew the results.

The dashboard currently has three different “modes”:

1. ***Metrics – Single Period***
2. ***Metrics – Compare Periods***
3. ***Journey Visualization – Single Period***
4. ***Journey Visualization – Compare Periods***

Metrics – Single Period mode allows the review the performance of the transit system during a single period of data. *Metrics – Compare Periods* mode allows the user to compare two different time periods and visualize the difference between the periods rather than the performance during a single period. The *Journey Visualization* modes allows the user to visualize passenger journeys throughout the transit network and compare how the flows change over time.

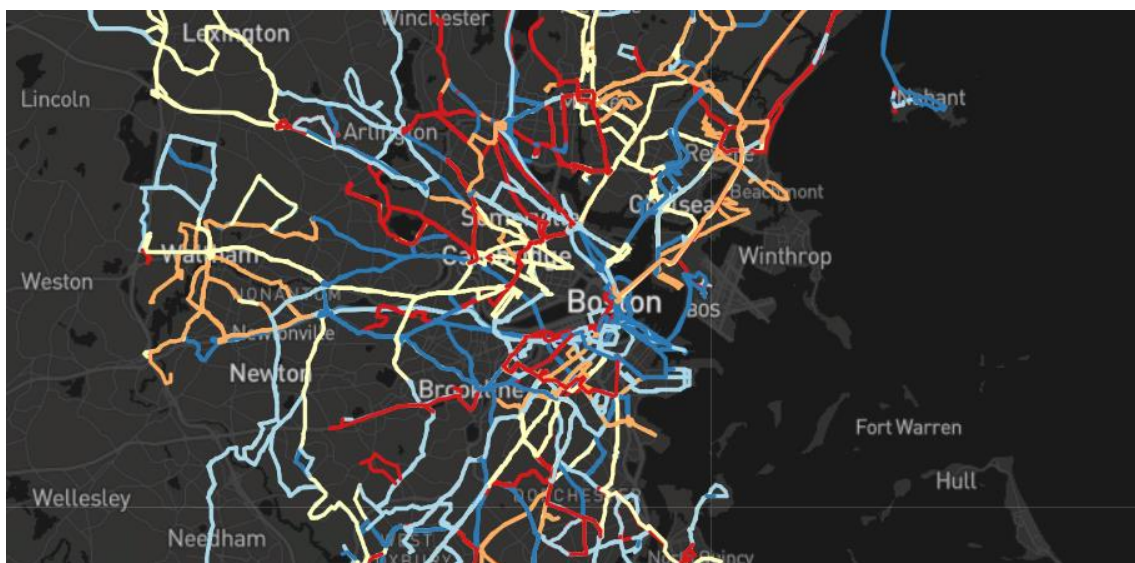
To load data for any mode, click the appropriate button under the “Data” header in the right-hand toolbar:



Each button will open a dialog box requesting the user to select a period (or two periods in the case of comparison modes). Select the desired period and click “Visualize”:



After a few seconds, the dialog box will disappear and a map will appear with an array of colorful lines representing the MBTA network (note that the initial appearance is slightly different for the journey visualization modes):



3. Navigating the Dashboard

ROVE has three main components: the static legend on the left, the map in the center, and the four toolbars on the right. These elements are somewhat different for the *Metrics* and *Journey Visualization* modes. Each is described separately in detail in this section.

3.1. Metrics Mode

3.1.1. Metrics Mode Legend Panel

The panel to the left of the map contains information about the current display.



The screenshot shows the Metrics Mode Legend Panel with the following content:

- Scheduled Freq. (/hr)**
 - Less than 1.1
 - 1.1 to 1.3
 - 1.3 to 1.6
 - 1.6 to 2.5
 - 2.5 or more
- Data From:** MBTA September 2019
- Routes Selected:** 159
- Level Selected:** Segment
- Direction Selected:** Both
- Statistic Selected:** Median
- Time Selected:** Full Day (24 hrs)
- Filters:**

Metric	Range
Scheduled Freq. (/hr)	0 - 120
Observed Freq. (/hr)	0 - 131
Running Time (min)	0 - 46
Scheduled Speed (mph)	0 - 53
Speed w/ Dwell (mph)	1 - 47
Speed w/o Dwell (mph)	1 - 46
Passenger Flow (pax)	0 - 0
Boardings (pax)	0 - 64
Sample Size (trips)	1 - 205
Crowding (%)	0 - 178

Annotations with red arrows point to the following elements:

- Metric that is currently being visualized
- Legend showing which line colors correspond to which values
- Selected data period
- Number of routes selected
- Current visualization level
- Current direction
- Current statistic (median, 90th %, etc.)
- Current time period
- Table showing the active filter settings for each metric

By default, the legend bins are set to create quintiles. The ranges of each bin can be adjusted using the Settings Panel (see Section 3.3). The colors are defined for each

metric such that red lines indicate poor performance. For example, low values would be colored red for speed, but high values would be colored red for running time. The high-low color scheme for each metric is set using a configuration file.

3.1.2. Metrics Mode Tool Panel

On the right-hand side, the “Tool” panel is automatically opened once the transit data is loaded. This panel contains some quick navigation tools as well as the filters that will be used to change the map display to enable different visualizations. Each of the boxes can be collapsed if needed using the small arrow next to the box name.

3.1.2.1. Controls Box

The “Controls” box has two buttons for map navigation: Home and Extents:



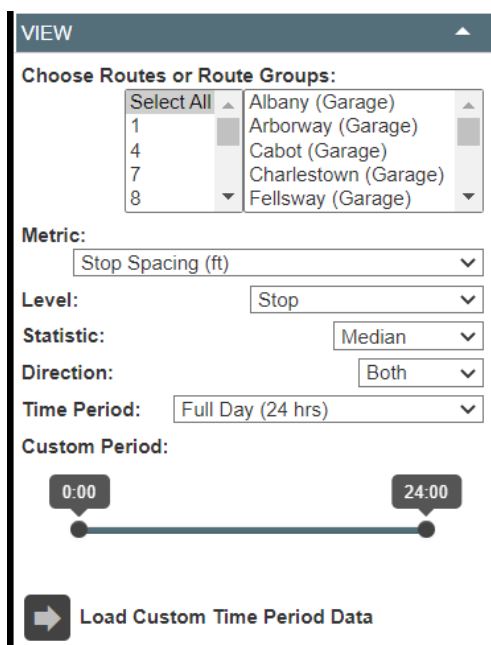
The Home button recenters the map to the middle of the transit network without changing the zoom level. Pressing SHIFT + C will also recentre the map. The Extents button recenters the map and zooms out so that the entire network is visible. The shortcut for this feature is SHIFT + Z.

3.1.2.2. View Box

The “View” box allows the user to change what is being displayed on the map. There are six different dimensions that can be filtered in this box: Route, Metric, Level, Statistic, Direction and Time Period. Time period can be set using a dropdown or slider.

Choose Routes or Route Groups: This filter allows the user to select a route or subset of routes for visualization. Hold CTRL to select multiple options, or SHIFT to select all routes between two options. “Select All” is the default first option. Selecting one of the garage names (i.e. Albany, Charlestown) will shown all routes that are based out of the selected garage. Selecting one of the route types (i.e. “Key Bus”, “Commuter”) will display all routes of the selected type. These groups are defined as part of a configuration file that can be modified as needed.

Metric: This dropdown menu allows the user to select the metric that is used in the visualization. The selected metric defines the colors of the map lines and the legend. There are over a dozen metrics available, including speed, passenger load and frequency. More information about how the metrics are calculated and their data sources is available in the ROVE Data Dictionary.



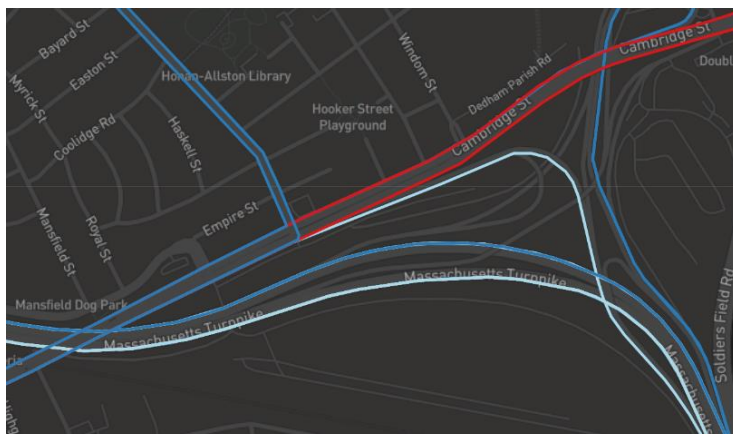
The screenshot shows the 'VIEW' configuration panel in the ROVE application. It includes several dropdown menus and a time period selector. The 'Choose Routes or Route Groups' section has a list with 'Select All' and route numbers 1, 4, 7, and 8, alongside a list of garage names: Albany (Garage), Arborway (Garage), Cabot (Garage), Charlestown (Garage), and Fellsway (Garage). The 'Metric' dropdown is set to 'Stop Spacing (ft)'. The 'Level' dropdown is set to 'Stop'. The 'Statistic' dropdown is set to 'Median'. The 'Direction' dropdown is set to 'Both'. The 'Time Period' dropdown is set to 'Full Day (24 hrs)'. Below these, a 'Custom Period' section shows a timeline from 0:00 to 24:00. At the bottom, there is a button labeled 'Load Custom Time Period Data'.

Level: This dropdown menu allows the user to select the resolution of the visualization. There are three primary options: Stop, Route and Timepoint. Stop shows the metrics at the stop-to-stop level for each route individually. Note that overlapping segments are drawn on top of one another and may be difficult to separate; the user can use the route filter to find metrics for a particular route. Route level shows the metrics aggregated for each route, although different directions are separated. Timepoint level shows the metrics aggregated between timepoints, which are generally larger than stop level segments, but smaller than the full route. Timepoint locations are defined by the agency.

Stop and timepoint metrics also have an 'aggregated' option, where metrics are aggregated across routes if the routes overlap for the full stop or timepoint segment. This can be useful for certain applications, like transit priority planning, where the aggregate measures within a corridor are more relevant than the measures of each route individually.

Statistic: There are two different statistics available for visualization: Median and Worst Decile. Median is the default and generally shows the median value for all trips in the data period. Worst Decile shows either the 10th percentile or the 90th percentile depending on the metric. For example, when speed is selected, then the 10th percentile is shown because low speed is considered to be poor performance. On the other hand, when running time is selected, then the 90th percentile is shown because high running time is considered to be poor performance. The setting for each metric can be changed in a configuration file.

Direction: This filter defines which direction(s) are visualized. For the MBTA, the options are “Inbound” and “Outbound”, per the agency’s GTFS feed. For clarity, individual directions are not separated when zoomed out, but when zoomed in to a certain level they will appear (see below). If the default “Both” option is selected, then outbound direction is shown when zoomed out. The “Peak” option is available for the AM Peak and PM Peak time periods. For the MBTA, the Peak option displays the Inbound direction during the AM Peak period and the Outbound direction during the PM Peak period. The Peak direction for every time periods can be modified in a configuration file.



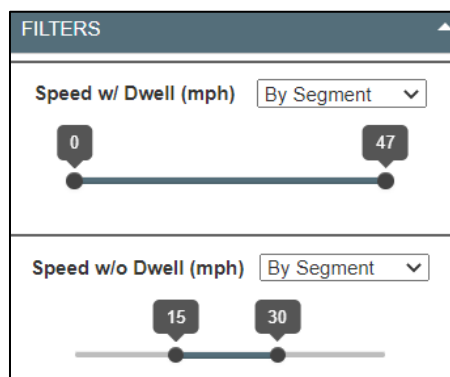
Time Period: There are two ways to define time periods. First, a predefined time period may be selected from the dropdown menu. Any records that fall within that time period are used in the calculation of the metrics. The number of options and their durations can be set in a configuration file. Second, a custom time period with 10-minute resolution can be selected using the slider. Using the custom time periods produces an estimate for the Worst Decile data, since it aggregates across several 10-minute periods but does not compute the true percentiles. The difference between the true percentile and the estimated percentile depends on the characteristics of the underlying data.

3.1.2.3. Filters Box

This box contains a number of sliders that can be used to filter the display by individual metric values. The maximum or minimum displayed value can be set by dragging the handles of the slider towards the desired value.

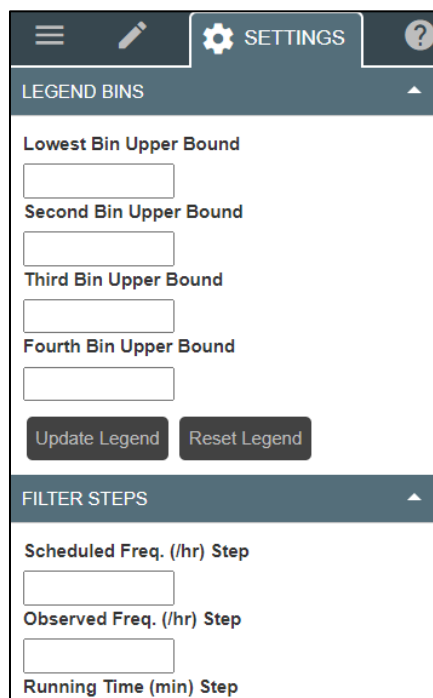
There is a “level” dropdown menu within each filter. Each metric can be filtered at any level (if the metric is available at that level), and the selected levels are independent from one another. For example, the user could filter observed frequency at the route level and crowding at the stop level to limit the display to high-frequency routes that experience significant crowding.

Each slider has a default step size depending on the range of values. For example, a speed filter ranging from 1 – 50 mph has a default step size of 5 mph, allowing the user to select values of 5 mph, 10 mph, 15 mph, etc. These step sizes can be changed by the user on the “Settings” panel as described below. The “Clear Filters” button at the top of the box is used to reset all filters.



3.1.3. Metrics Mode Settings Panel

The settings panel was added in response to user feedback to enable more flexible display and filtering. There are two boxes in the panel: Legend Bins and Filter Steps.



The Legend Bins box allows the user to specify the ranges for each of the 5 bins in the legend as follows:

- **Lowest Bin Range:** Minimum Value – Lowest Bin Upper Bound
- **Second Bin Range:** Lowest Bin Upper Bound – Second Bin Upper Bound
- **Third Bin Range:** Second Bin Upper Bound – Third Bin Upper Bound
- **Fourth Bin Range:** Third Bin Upper Bound – Fourth Bin Upper Bound
- **Highest Bin Range:** Fourth Bin Upper Bound – Maximum Value

The color of the lowest and highest bin (either red or blue) is determined by the high-low setting for the visualized metric, depending on whether high or low values represent poor performance. Bin ranges must be ascending from lowest to highest, otherwise the changes will not be implemented. Click Update to execute a change and reset to revert to the default (quintiles). Note that these values will revert to the default each time a different metric is selected for visualization.

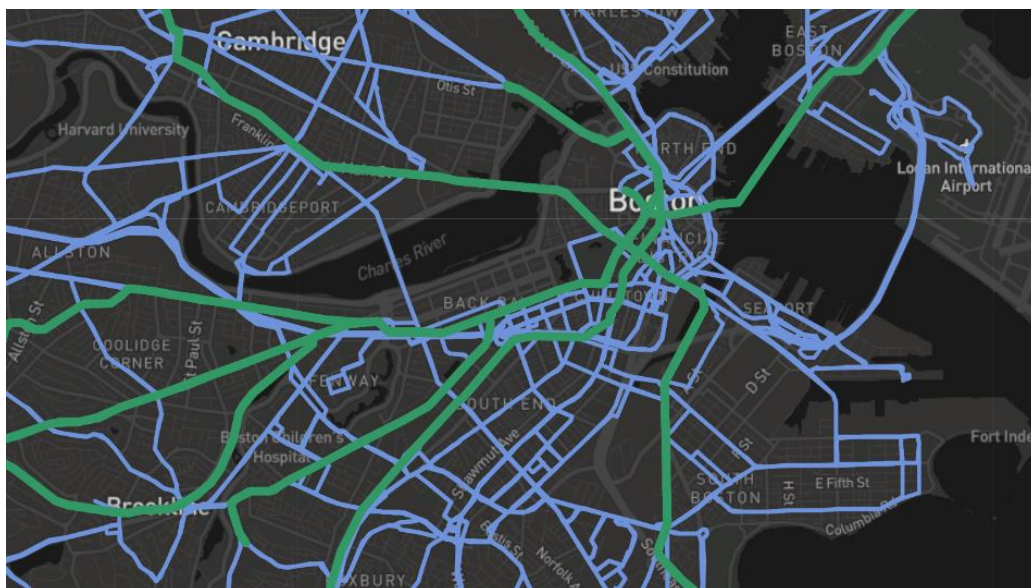
The Filter Steps box allows the user to adjust the step size in each of the metric slider filters within the Tool panel. The value can be changed for any filter. Scroll down for the update and reset buttons. Step values can be changed for one filter at a time or all filters.

3.2. Journey Visualization Modes

The journey visualization mode allows a user to select stops or timepoints and display the passenger journeys that begin, end or include that stop or timepoint. A single stop or timepoint can be selected by clicking on any transit route on the map. Multiple stops can be selected with the “lasso” tool (see Section 3.2.2.2.). Once a selection is made, the remaining stops or timepoints are re-colored to indicate the passenger flow to or from the selected stop / timepoint. Clicking on the other parts of the network will display a pop-up box containing the stop / timepoint information and the passenger flow to / from that stop or timepoint. The “Clear Selection” button (Section 3.2.2.2.) must be clicked to switch from one selection to another.

Note that, unlike the *Metric* selection modes, the rail network is included in the *Journey Visualization* modes. This permits a full multi-modal journey visualization. Rail stops and timepoints can be selected just like bus stops and timepoints. The initial view of the MBTA network, before any selection, shows the rail network in a different color and thicker line in order to differentiate it from the bus network. An example of this view is shown below.

The *Journey Visualization – Compare Periods* mode allows the user to compare flows between two time periods, with an identical interface.

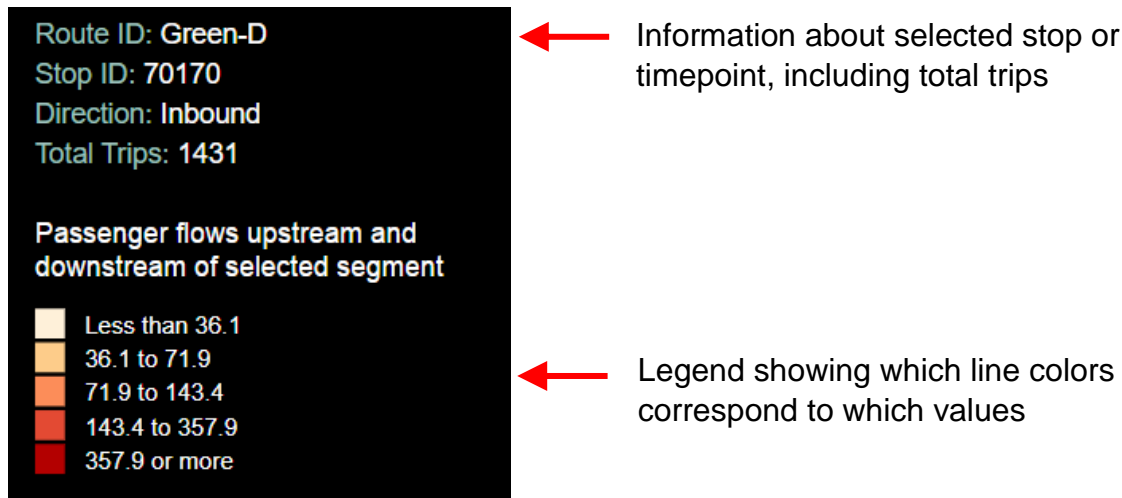


3.2.1. Journey Visualization Mode Legend Panel

The panel to the left of the map contains information about the current display. When no stop or timepoint is selected, the legend shows only the metadata for the selected time period:

Data From: MBTA January 2020	←	Selected data period
Resolution Selected: Stop	←	Current visualization level
Routes Selected: 168	←	Number of routes selected
Direction Selected: Both	←	Current direction
Time Selected: Full Day (24 hrs)	←	Current time period

When a stop or timepoint has been selected, however, two new elements appear. A second table appears in the panel with information about the selected stop or timepoint. A legend also appears to indicate which colors correspond to which passenger flow values. By default, the legend bin cutoffs are set to 2.5%, 5.0%, 10.0% and 25.0% to create bins with meaningful sizes.



3.2.2. Journey Visualization Mode Tool Panel

On the right-hand side, the “Tool” panel is automatically opened once the transit data is loaded. This panel contains some quick navigation tools as well as all filters that will be used to change the map display to enable different visualizations. Each of the boxes can be collapsed if needed using the small arrow next to the box name.

3.2.2.1. Controls Box

The “Controls” box has two buttons for map navigation: Home and Extents:



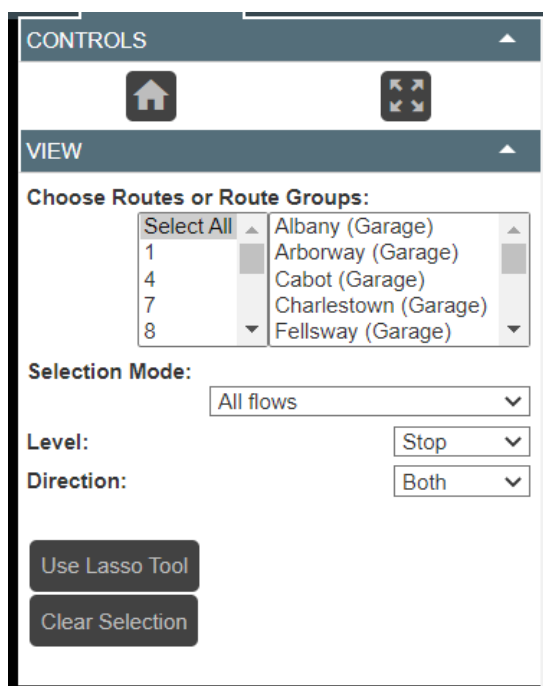
The Home button recenters the map to the middle of the transit network without changing the zoom level. Pressing SHIFT + C will also recentre the map. The Extents button recenters the map and zooms out so that the entire network is visible. The shortcut for this feature is SHIFT + Z.

3.2.2.2. View Box

The “View” box allows the user to change what is being displayed on the map. There are four different dimensions that can be filtered in this box: Route, Selection Mode, Level, and Direction.

Choose Routes or Route Groups: This filter allows the user to select a route or subset of routes for visualization. Hold CTRL to select multiple options, or SHIFT to select all routes between two options. “Select All” is the default first option, and it is followed by

several route groups: Garages and Route Types. Selecting one of the garage names (i.e. Albany, Charlestown) will show all routes that are based out of the selected garage. Selecting one of the route types (i.e. “Key Bus”, “Commuter”) will display all routes of the selected type. These groups are defined as part of a configuration file that can be modified as needed.



The screenshot shows the 'CONTROLS' panel of the ROVE application. It features a 'VIEW' section with a 'Choose Routes or Route Groups:' dropdown menu. This menu has a list on the left with options 'Select All', '1', '4', '7', and '8', and a list on the right with options 'Albany (Garage)', 'Arborway (Garage)', 'Cabot (Garage)', 'Charlestown (Garage)', and 'Fellsway (Garage)'. Below this is a 'Selection Mode:' dropdown menu currently set to 'All flows'. There are also 'Level:' and 'Direction:' dropdown menus, currently set to 'Stop' and 'Both' respectively. At the bottom of the panel are two buttons: 'Use Lasso Tool' and 'Clear Selection'.

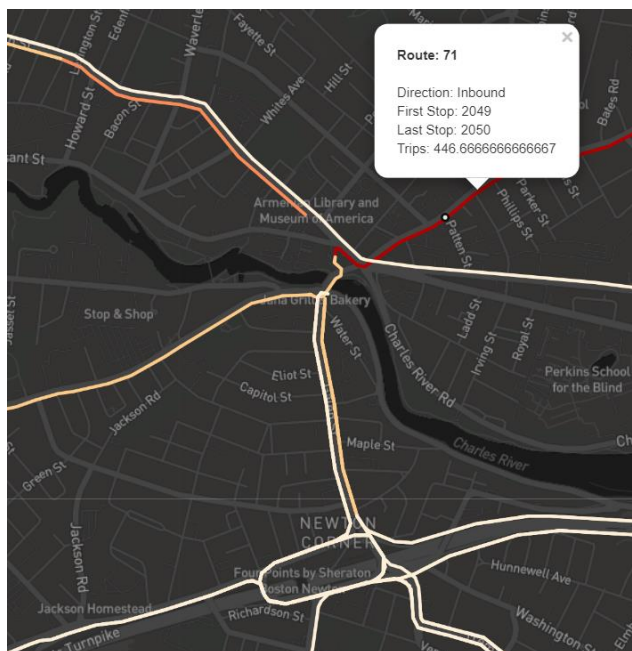
Selection Mode: This dropdown menu allows the user to toggle between six different types of passenger flow visualizations. The first option, “All flows”, will display the passenger flows for all journeys that include the selected stop or timepoint. The second and third options, “Upstream flows” and “Downstream flows”, show only the passenger flows that occur before or after the selected stop or timepoint, respectively. The “Origins of Alighting Pax” option shows the passenger flows for all journeys that *end* at the selected stop or timepoint. The “Destinations of Boarding Pax” option shows the passenger flows for all journeys that *begin* at the selected stop or timepoint. Finally, the “Transfer Journeys Only” option is similar to “All flows”, except that only journeys that involve at least one transfer are included.

When a stop or timepoint is selected, a small circle appears at the bus stops upstream and downstream of the selected point. This is intended to help the user identify their selection. Clicking on either of the stops will raise a popup with the stop ID and name.

Level: This dropdown menu allows the user to select the resolution of the visualization. There are two options: Stop and Timepoint. “Stop” shows the passenger flows at the stop-to-stop level for each route individually. Note that overlapping segments are drawn on top

of one another and may be difficult to separate; the user can use the route filter to find flows for a particular route. “Timepoint” shows the passenger flows aggregated between timepoints, which are generally larger than stop segments, but smaller than the full route. The location of timepoints are defined by the agency.

Direction: This filter defines which direction(s) are visualized. For the MBTA, the options are “Inbound” and “Outbound”, per the agency’s GTFS feed. For clarity, individual directions are not separated when zoomed out, but when zoomed in to a certain level they will appear (see below). If the default “Both” option is selected, then outbound direction is shown when zoomed out. The “Peak” option is available for the AM Peak and PM Peak time periods. For the MBTA, the Peak option displays the Inbound direction during the AM Peak period and the Outbound direction during the PM Peak period. The Peak direction for every time period can be modified in a configuration file.



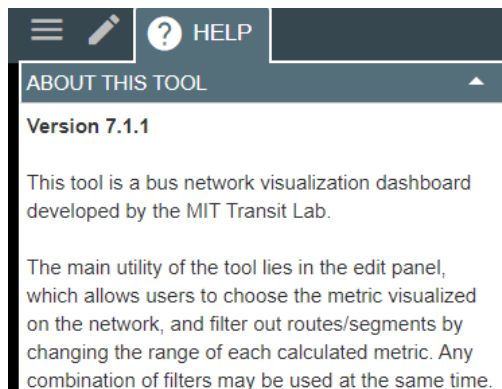
Lasso Tool Button: This button in the View Box, as well as its corresponding icon in the top right hand corner of the map, enables the “lasso” selection tool for selecting multiple stops or timepoints.

Load Before/After Data Button: In comparison mode, the user has the option to load the passenger flow data for the baseline and comparison periods once a selection is made. This will take a few seconds to load and appear in the popup windows.

Clear Selection Button: The clear selection button removes the existing selection and returns the user to the initial journey visualization map, displaying all bus routes and rail lines in the network.

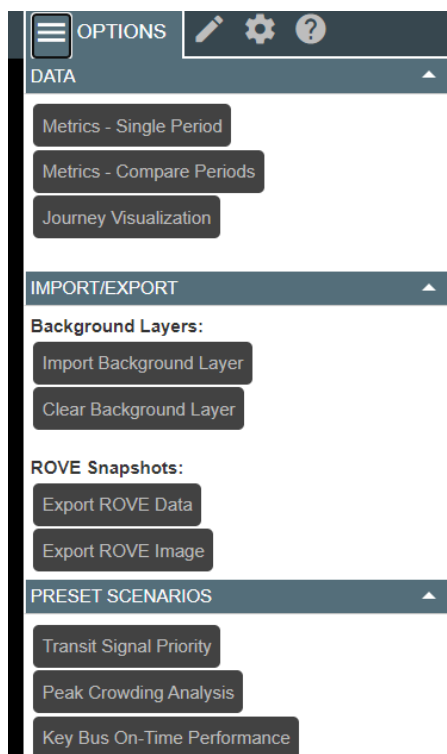
3.3. All Modes - Help Panel

The Help Panel provides information about the tool, outlining the basic functionality and describing some quick tips for navigation. At the bottom is a link to the Feedback Form. This is a Google Form that allows the user to provide feedback, including bugs and feature requests, to the developers and view feedback from other users.



3.4. All Modes - Options Panel

The last panel is the Options Panel, which was used in Section 2 to load new data. This panel is common to all modes. There are several other helpful buttons here as well.

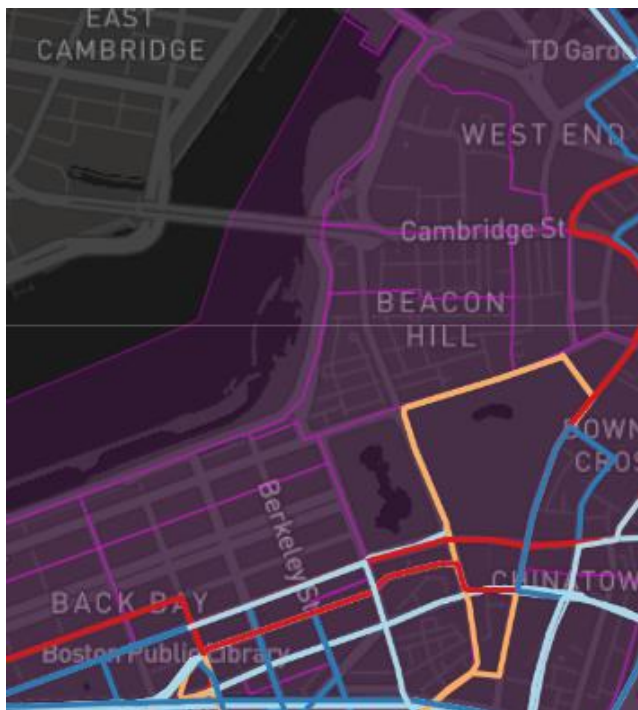


3.4.1. Data Box

The three buttons in the Data box are used to load transit data. The “Metrics – Single Period” button allows the user to select one time period and load the dashboard. The “Metrics - Compare Periods” button allows the user to select two time periods and compare the change in performance metrics between the two periods. The “Journey Visualization” button allows the user to select one time period and load the journey visualization dashboard.

3.4.2. Import/Export Box

This box allows the user to add non-transit background layers to the map. The set of background layers that are available is specified in the configuration file; any geospatial data in GeoJSON file format can be included. Examples may include traffic signal locations, census tracts, municipal boundaries, etc. One layer may be loaded at a time, and the “Clear Background Layer” button is used to remove them. Census tract boundaries are shown below as an example. Any additional fields included in the GeoJSON file will appear in a popup window when the geometry is clicked. A semi-transparent pink color is used for background layers as it is easily discernible from the transit line colors.



There are also two export buttons: “Export ROVE Data” and “Export ROVE Image”. The “Export ROVE Data” button allows the user to export all metrics in the current visualization to a CSV spreadsheet file. Depending on which level is selected, each row will represent a stop, corridor or route. The columns include information about the segment/corridor/route and all metrics. Only stop/corridors/routes which fall within the current filter states will be included in the export, allowing the user to choose a set of routes, or certain metric ranges, etc., and produce a table for further analysis or inclusion into a report.

Route	Direction	First Stop ID	First Stop Name	First Stop City	Last Stop ID	Last Stop Name	Last Stop City	Signal	Scheduled Freq. (/hr)
1	Outbound	64	Dudley Square	Boston	1	Washington St opp Ruggles St	Boston	FALSE	3.22
1	Outbound	1	Washington St opp Ruggles St	Boston	2	Washington St @ Melnea Cass Blvd	Boston	TRUE	3.22
1	Outbound	2	Washington St @ Melnea Cass Blv	Boston	6	Melnea Cass Blvd @ Harrison Ave	Boston	TRUE	3.22
1	Outbound	6	Melnea Cass Blvd @ Harrison Ave	Boston	10003	Albany St opp Randall St	Boston	TRUE	3.22
1	Outbound	10003	Albany St opp Randall St	Boston	57	Massachusetts Ave @ Albany St	Boston	TRUE	3.22
1	Outbound	57	Massachusetts Ave @ Albany St	Boston	58	Massachusetts Ave @ Harrison Ave	Boston	FALSE	3.22
1	Outbound	58	Massachusetts Ave @ Harrison Av	Boston	10590	Massachusetts Ave @ Washington St	Boston	TRUE	3.22
1	Outbound	10590	Massachusetts Ave @ Washington	Boston	87	Massachusetts Ave @ Tremont St	Boston	TRUE	3.22
1	Outbound	87	Massachusetts Ave @ Tremont St	Boston	88	Massachusetts Ave @ Columbus Ave	Boston	FALSE	3.22
1	Outbound	88	Massachusetts Ave @ Columbus A	Boston	188	Massachusetts Ave @ Massachusetts Ave Station	Boston	TRUE	3.22
1	Outbound	188	Massachusetts Ave @ Massachus	Boston	89	Massachusetts Ave @ St Botolph St	Boston	TRUE	3.22

For stops and corridors, the first stop ID and last stop ID in the stop-to-stop segment is included in the export, along with the stop names and the municipality in which the stop is located. This can be helpful for additional filtering. Furthermore, there is a “Signal” column which indicates whether the given segment or corridor contains a traffic signal. This feature allows quick filtering for transit signal priority projects.

In comparison mode, the export table includes three sets of metrics: the metrics for the selected baseline period, metrics for the selected comparison period and the difference between the two (selected – baseline).

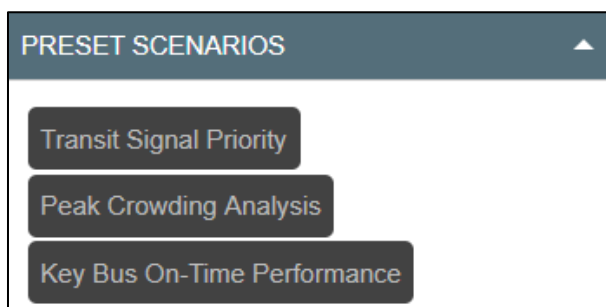
In journey visualization mode, the passenger flow data can also be exported. Each row of the CSV export table corresponds to a stop or timepoint that has non-zero passenger flow to or from the selection. There is also a “Selected” column that indicates whether or not each row is part of the active selection. The table is sorted such that selected rows appear first.

The “Export ROVE Image” button creates a .PNG image file of the current map view. For technical reasons it does not include the left- or right-hand panels. This feature may be helpful if screenshots are not possible.

3.4.3. Pre-set Scenarios Box

The buttons in this box allow the user to select from predefined scenarios that automatically determine the displayed metrics and filter states. These buttons can be used for quick navigation to a set of filter states that are commonly used by analysts and

planners. The name and settings associated with each of the predefined scenarios can be changed to meet the needs of users by modifying a configuration file.



3.5. The Map

Controls for the map in the center of the dashboard are designed to be intuitive: scroll to zoom in/out, click and drag to pan, double click to zoom in. The map includes a limiting box to prevent any accidental panning beyond the extents of the transit network. The underlying map is powered by Mapbox and includes the street network and neighborhood names as well as certain Points of Interest.

Zooming in to a certain predefined level will cause offset lines to appear for opposing directions. One of the key features of the map is the ability to click on any transit line and view the line details and the values of any performance metric (or passenger flow when in the *Journey Visualization* modes). When the line is clicked, a popup box will appear showing all relevant information for that line. If the comparison mode is selected, then metrics for the baseline period, comparison period and the difference between periods will be shown in the popup display.

