TALLYMATICS WCP Server Geo-Tracking Solution

Version 1.6, January 31, 2023

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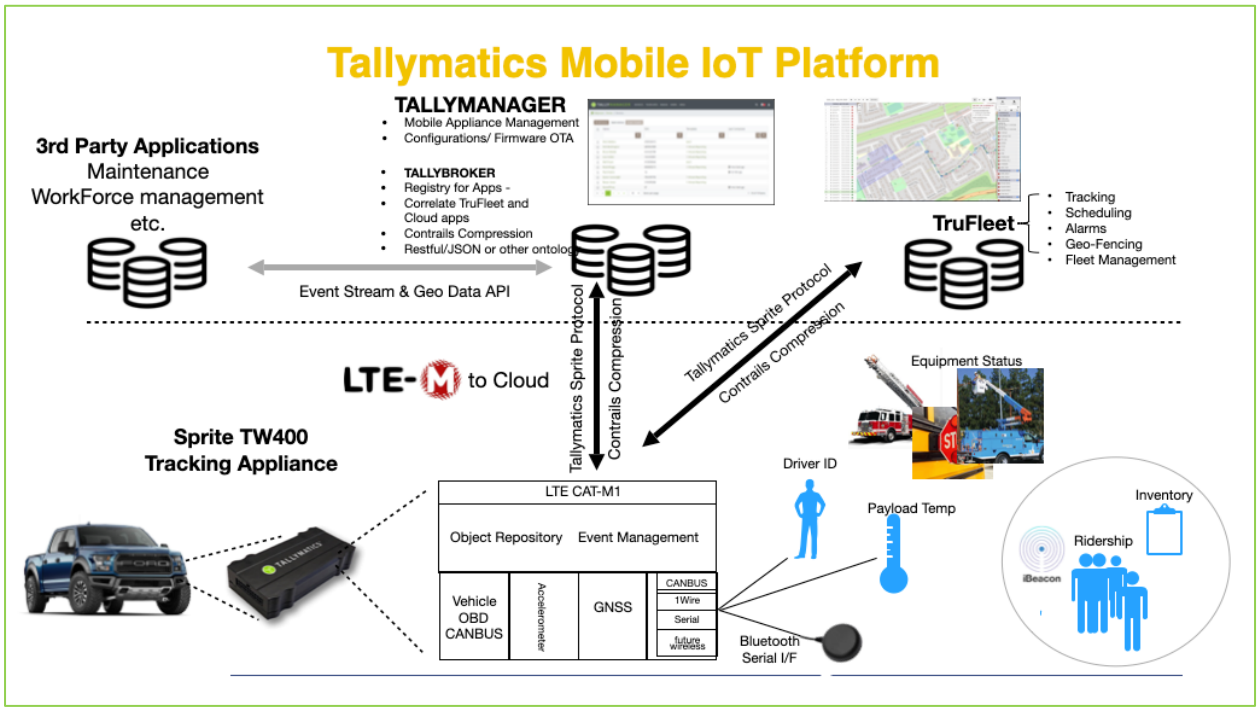
1 INTRODUCTION

TALLYMATICS Inc., a wholly owned subsidiary of the Calian group of companies, sells, markets, manufactures and provides a comprehensive geo-tracking solution, comprised of the following major components:

1. TruFleet Cloud-based Geo- tracking application
2. Sprite TW400 LTE-M Tracker device with LTE-M data service
3. TALLYMANAGER Cloud-based device Manager
    a. TALLYBROKER Cloud-based 3rd Party Application portal for integrating with 3rd Party Applications

Together, these components form an easy to use, efficient and effective tracking solution for all types of assets and personnel.

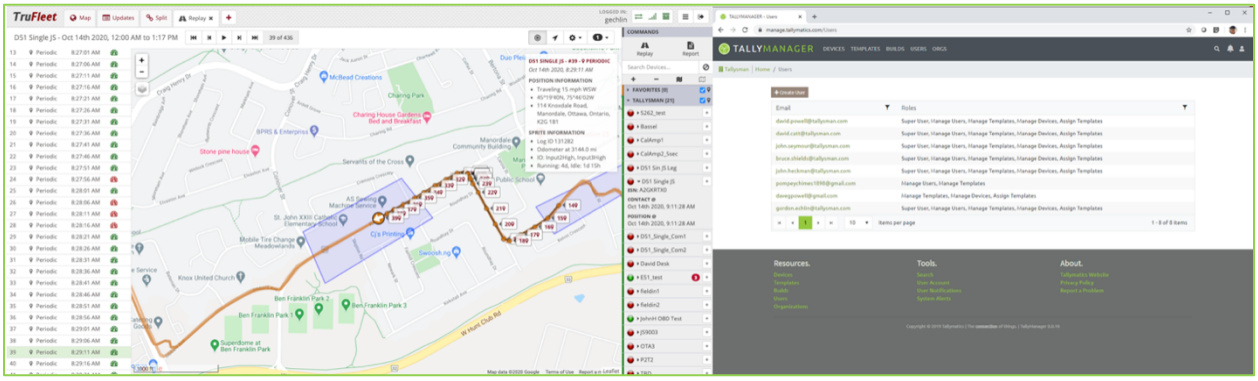


TruFleet is the geo-tracking application layer, which can also manage GNSS information from 3rd party LMR radios equipped with build in GPS capability, or with tethered TALLYMATICS Smart Antennas and Sprite 2XX devices to supply I/O or enhanced telematics functionality. On LMR networks, TruFleet is often installed on a server local to a repeater or at the network control station. TALLYMATICS encourages using our cloud hosted service **for LTE-M units**, however all devices support both models, local or cloud-hosted.

2 SYSTEM OVERVIEW

TALLYMATICS WCP server provides geo-tracking services installed on a local server, or the server can be deployed as a hosted, cloud-based solution. TALLYMATICS hosts and manages the TruFleet Cloud-based geo-location application and the TALLYMANAGER Cloud-Based device management software, which are accessible via standard web-browser from any type of device: Personal Computer, Tablet or Smart Phone.

The TruFleet Service provides all geo-tracking functionality and reports for devices: radio or telematics. The TALLYMANAGER Service is used to activate/deactivate cellular service on devices, provide over the air updates, and configure the TW400 LTE-M devices' reporting frequency, geo-point interval recording rate and the programmable events derived from the TW400's onboard resources, serial buses, inputs and outputs. The TALLYMANAGER also manages Over The Air (OTA) updates of new firmware for TW400 LTE-M devices, thereby "future-proofing" the solution as new features are developed over time and transmitted to the devices.



Sprite TW400 LTE-M Tracker devices are installed in vehicles, either via a cable connecting the device to the vehicle's On Board Diagnostic (OBD) port or by direct connection to power, ground and ignition. Installation is very easy, as typically there is no requirement for an external antenna even when the device is installed underneath the vehicle's dashboard. The Sprite TW400 LTE-M Tracker uses LTE-M, which is a very reliable, lower bandwidth version of LTE cellular with better transmission characteristics.

Figure 1: Sprite TW400 LTE-M Tracker and OBD2 cables

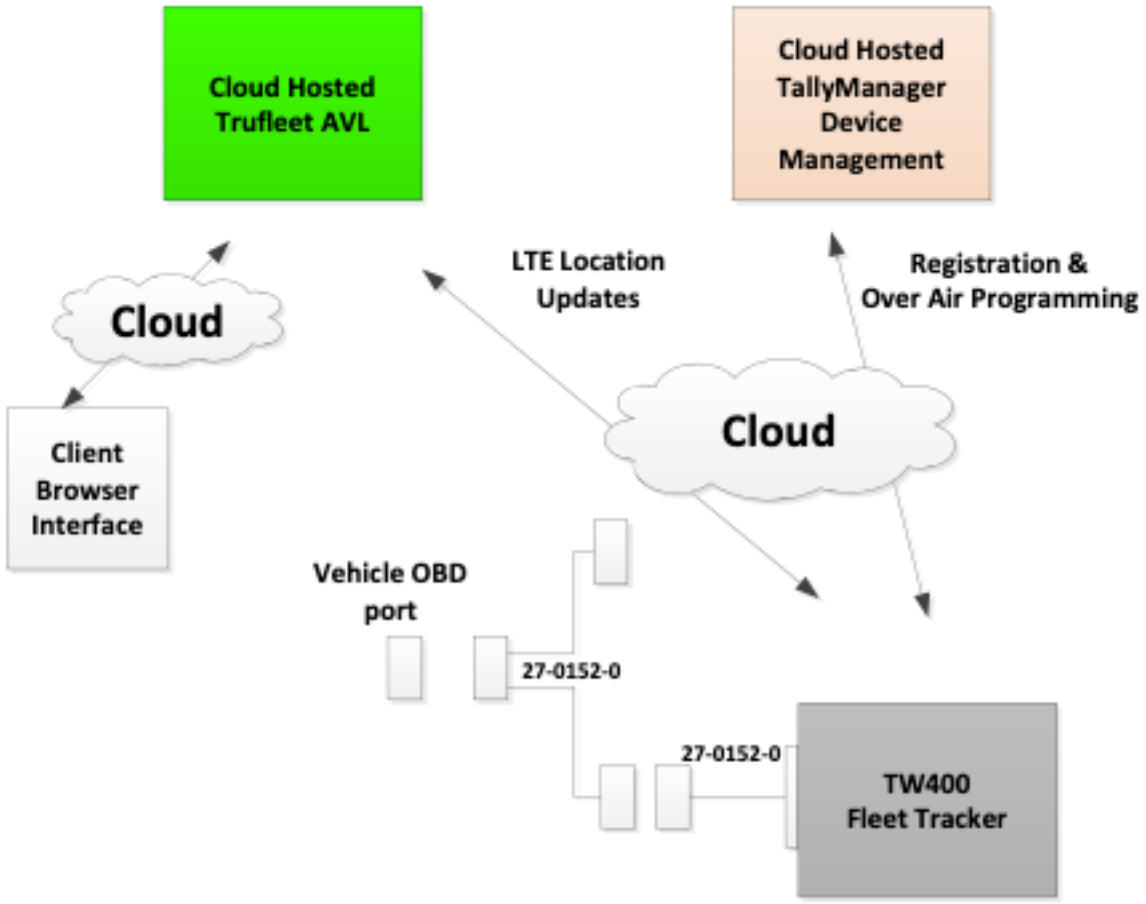


Figure 2 Simplified System Diagram – cloud hosted

The TW400 is not the only device that can report to the TruFleet application. TruFleet can monitor the location of any radio that can generate GPS information and has been configured to report to TruFleet, such as MotoTRBO, Tait, and Kenwood Land Mobile Radio (LMR) radios. TALLYMATICS' line of Sprite TW2XX devices can provide extra functionality, such as extra I/O's and Contrails compatibility (see 3.3.2) to the radios. The TW5X42, the TW5X62 (see 5.5.1), and the TW5x77 are smart antennas (receiver antennas) that also add functionality to radios. TALLYMATICS has also adding Push To Talk over Cellular (PoC) devices to TruFleet.

In LMR networks, the TruFleet WCP server is typically deployed local at a repeater or Control Station, or it can be hosted in the Cloud if there is an IP gateway available. Locally hosted or web hosted, all types of supported devices can be tracked under one system.

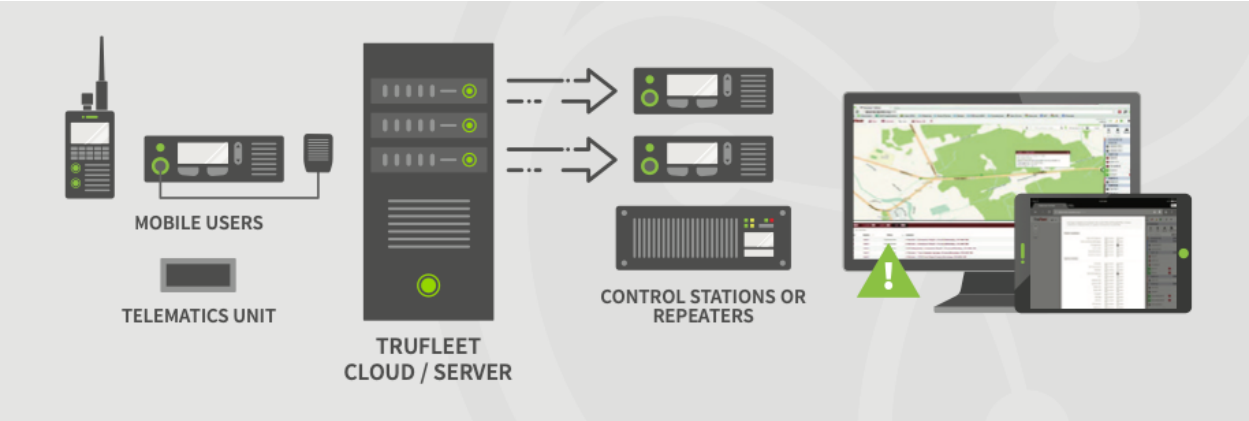
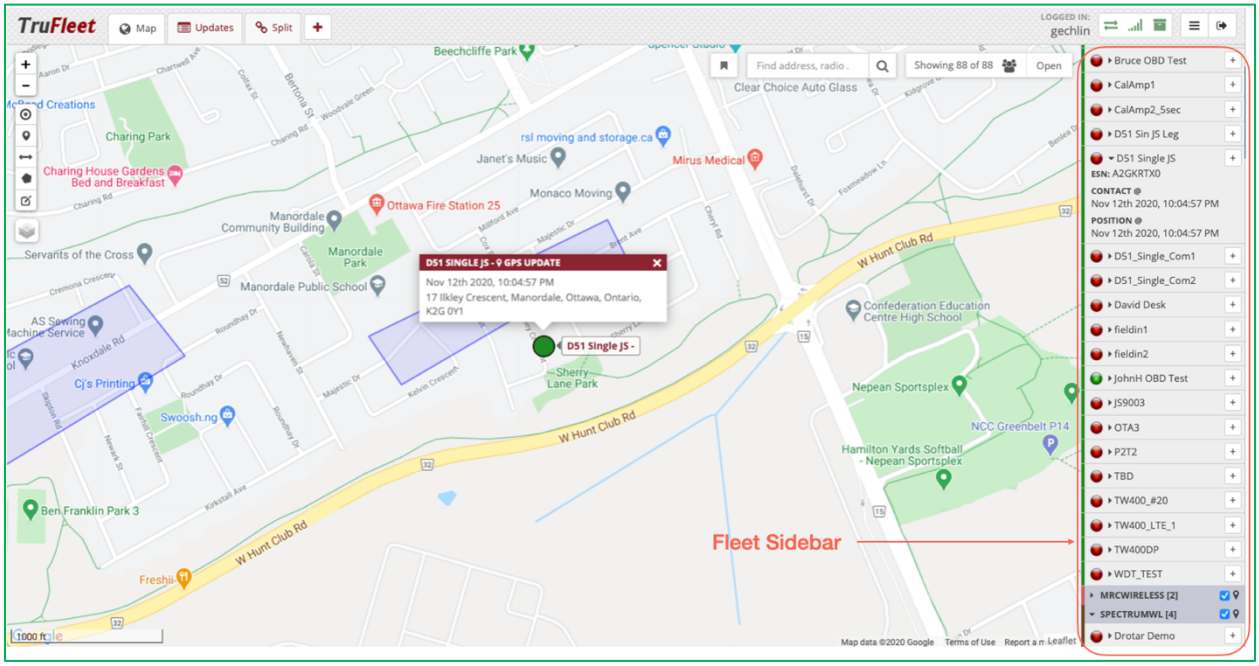


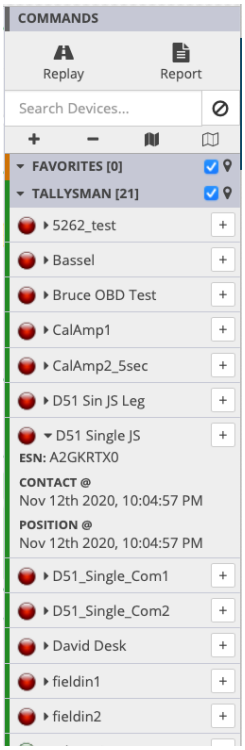
Figure 3: Installation local to Radio system

3 TruFleet Geo-Tracking Application

TruFleet is a powerful and comprehensive geo-tracking and Fleet Management application, that emphasizes User Interface and ease of use. It has all of the most important features that any AVL application has, but does away with confusion by distilling functionality to several key control interfaces.



3.1 Fleet Side Bar



The Fleet Sidebar is the tool that allows you to rapidly locate devices and to change the visibility of fleets and specific vehicles on the map. The sidebar provides commands and a list of all radios, grouped into their respective fleets. It can be collapsed/restored by clicking the arrow icon at the upper far right of the page.

Available commands:

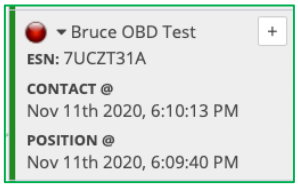
- Replay: Generate a route replay for a radio during a specific time interval in the past.
- Report: Generate a report (e.g. PDF)
- + Expand all Fleets
- - Collapse all Fleets
- Show all Fleets
- Hide All Fleets

Entering text in "Search Radios..." will filter the displayed radios that match the text.

Each radio has an activity icon that indicates how recently it was seen on the radio network:

- Green: Seen in the last 15 minutes
- Yellow: Seen in the last hour
- Red: Seen more than an hour ago
- Grey: Never seen on radio network

Additionally, if the activity icon has a green background, then a GPS position has been received from that radio in the last 15 minutes.

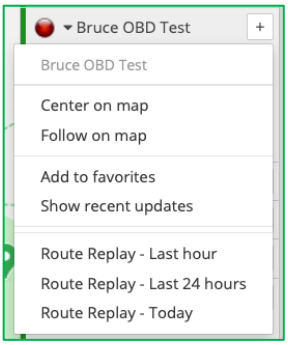


Clicking the name of the radio will expand to display additional information for the radio.

The red "badge" displays how many updates have been received for the radio since logging in. Clicking the badge will reset the counter.

The "+" button brings up the radio menu for the radio.

3.1.1 Radio Menu



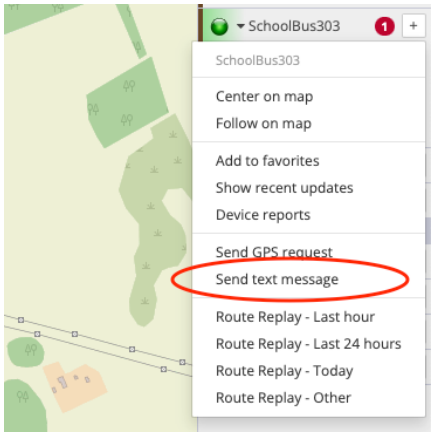
The radio menu will display a list of commands for a specific radio. It can be brought up from multiple places in the application (e.g. clicking a "+" button in the sidebar).

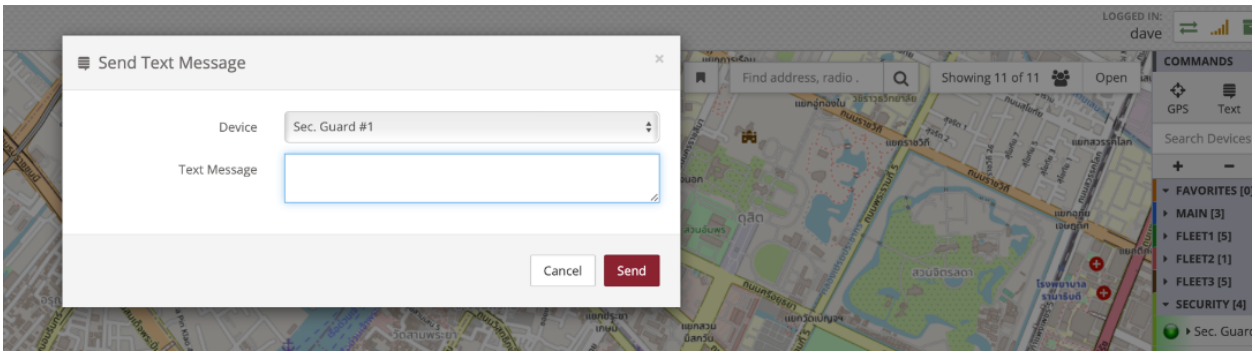
Center on map: Centers the real-time map to display the current position of the radio.

- Follow on map: The real-time map will follow the radio as new GPS updates are received
- Add/Remove from favorites: Adds or removes the radio from the special user defined "favorites" fleet
- Show recent updates: Displays the recent updates received for the radio in the Updates tab
- Route Replay - Last hour: Generates a route replay for where the radio has been in the past hour in a single click
- Route Replay - Last 24 hours: Generates a route replay for where the radio has been in the past 24 hours in a single click
- Route Replay – Today: Generates a route replay for where the radio has been today.

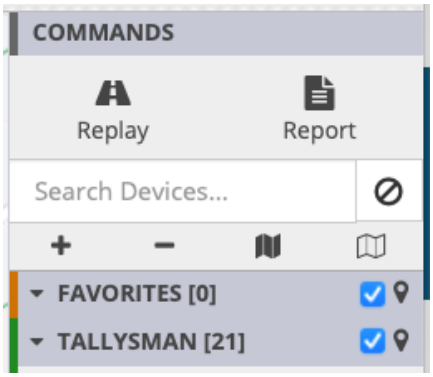
3.1.1.1 Text Messages to Radios

Another nice real-time feature for communicating with the field is the ability to send a text message from the radio menu. This will only be shown when the device in question is a radio from Motorola, Tait or Kenwood. When selected, a text box to enter the text will be displayed. When a text is received, a notification will be displayed, and the text can be read here or in the “Updates” page (Section 3.3).





3.1.2 Favorites

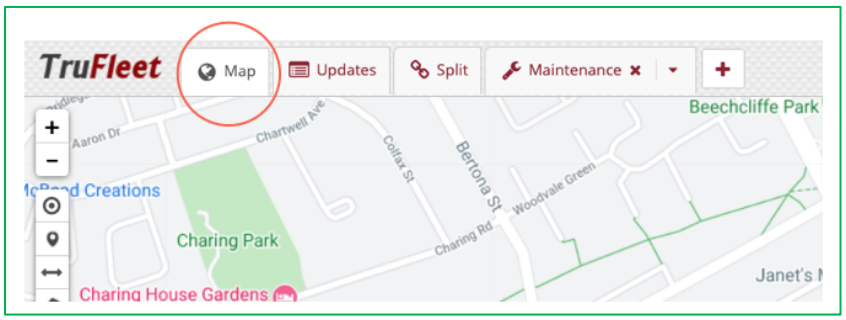


The Favorites is a powerful tool that allows users to focus their attention on a specific set of radios. It is a special fleet that users can add radios to by selecting "Add to favorites" from a radio command menu. Each user will have its own customized Favorites.

Some benefits from using Favorites include:

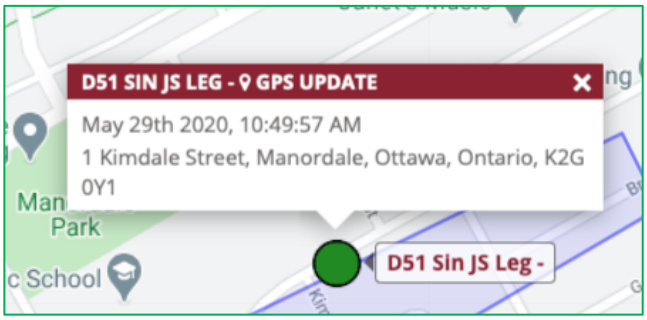
- The radios will always be clearly visible on the top of the radio menu under the Favorites fleet
- The map filter provides an option to only display radios that are part of the Favorites

3.2 MAP TAB

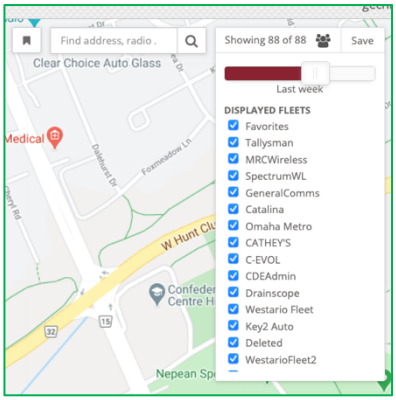


The contents displayed by the main window of the application are determined by a set of tabs in the upper left corner of the application. The Map Tab is the traditional mapping view expected in an AVL application.

The Real-time Map tab shows the latest position of every radio. The icons on the map are color coded based on fleet and an arrow points in the direction of travel. Clicking the icon will bring up information about the GPS report. Clicking the label with the radio's name will bring up a menu for the radio.



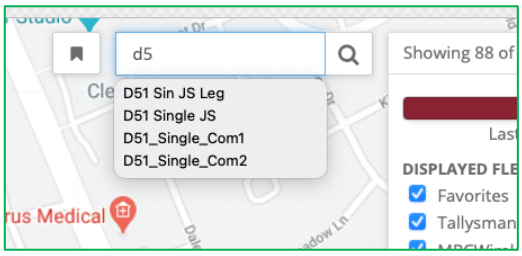
3.2.1 Map Filter



In large systems, the map can get cluttered with too many radios. The map filter will reduce the number of radios shown on the map based on how recently we received a GPS update for the radio and which fleet the radio belongs to. Clicking the "Save" button will update the map filter.

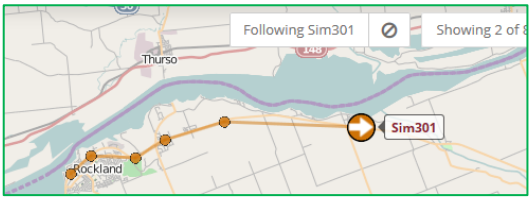
3.2.2 Search

The search bar on the map can be used to find an existing radio, Point of Interest or geofence. Otherwise, it can be used to lookup an a street address and find it on the map.



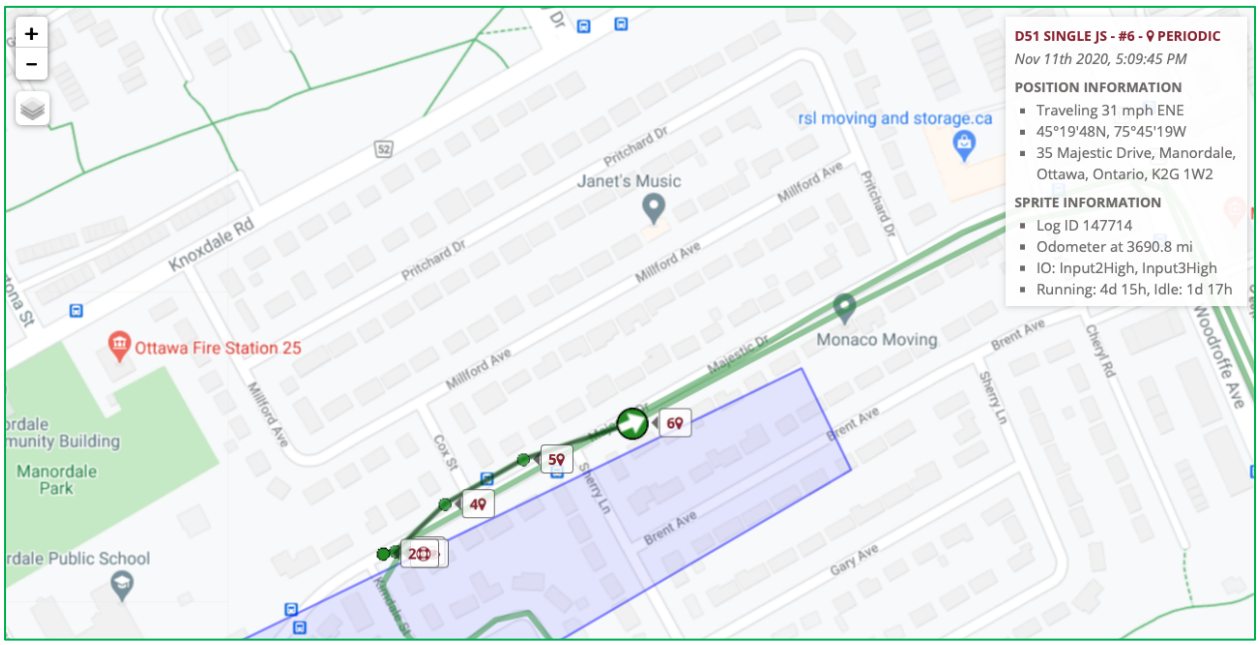
3.2.3 Following a Radio

A radio can be followed on the map by selecting "Follow on map" from a radio menu. When an update is received for the followed radio, it will be automatically re-centered on the map. Clicking the "cancel" button will stop following the radio.



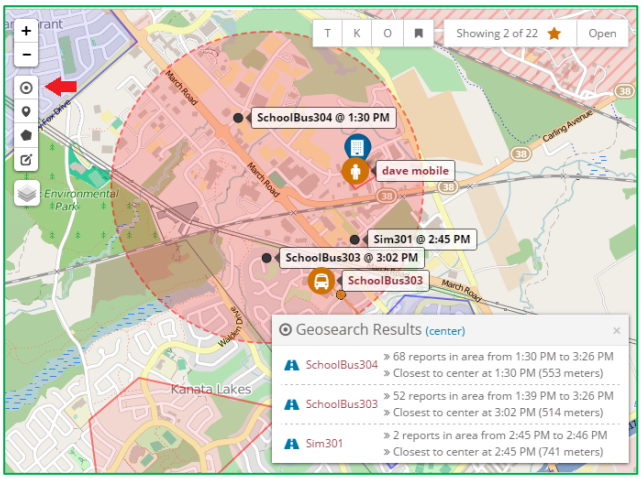
3.2.4 Breadcrumbs

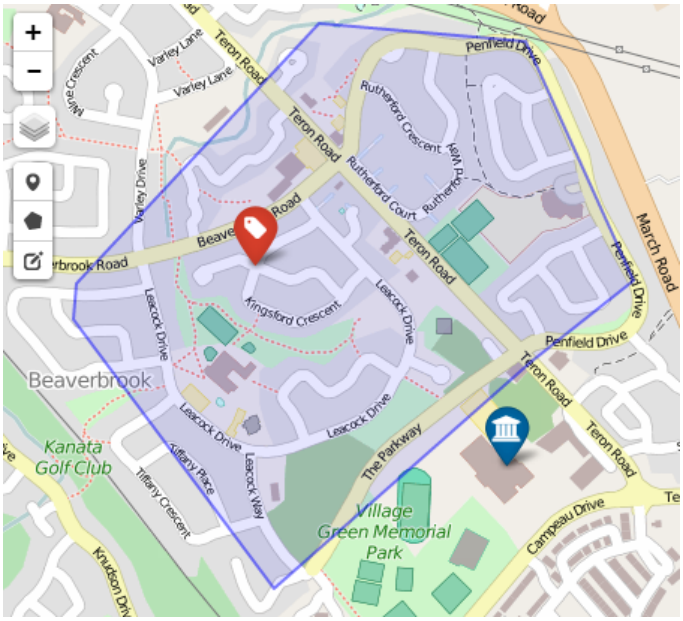
The map can show a breadcrumb trail of the route the radio has taken. The application settings specify the maximum number of breadcrumb points shown for each radio, and when the breadcrumb points expire and disappear from the map - this makes it easy to quickly see which radios are currently moving about.



3.2.5 Geosearch

The Geosearch tool allows you to search for all radios that were in an area. After clicking the Geosearch button on the left hand panel, you can click and drag to draw a circle on the map and provide a time frame. The server will return a list of radios that were in the area during that period of time. Clicking on the "road" icon next to the radio will do a Route Replay for the radio during that time frame.



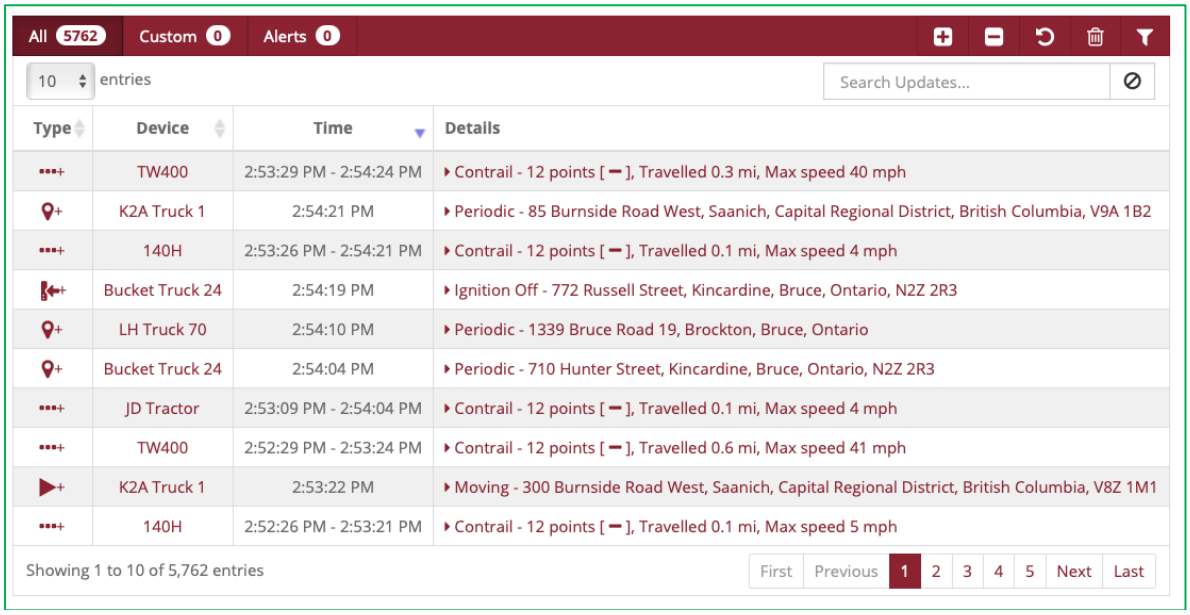


3.2.6 Points of Interest and Geofences

Points of Interests and Geofences can added and modified using the draw controls in the top left corner. A Point of Interest will place a marker on the map with a customizable colour and icon. Once a geofence is added, the server will check to see when a radio has entered or exited a geofence and create a Geofence Alert if necessary. A user must be given permission to manage the Points of Interest or Geofences on the system.

3.3 UPDATES TAB

Updates from radios are displayed in a table format in the Real-time Updates tab. By default, the most recent updates are shown on the top and will hold the last 500 updates. The Split Tab allows the bottom half of the display to be updates and the upper half mapping, with adjustable ratio of display.

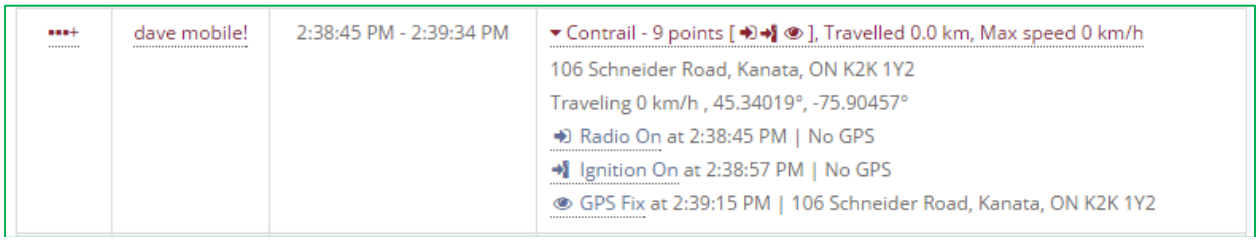


3.3.1 Columns

- Type: Indicates the type of update. If there is a "+" next to the icon, the update has a GPS position and can be clicked to show the update on the map.
- Device: Indicates the radio associated with the update. Clicking the name will bring up the radio command menu.
- Time: Indicates when the update occurred.
- Details: Provides information for the update, clicking this will expand to show additional details.

3.3.2 Contrails Compression Updates

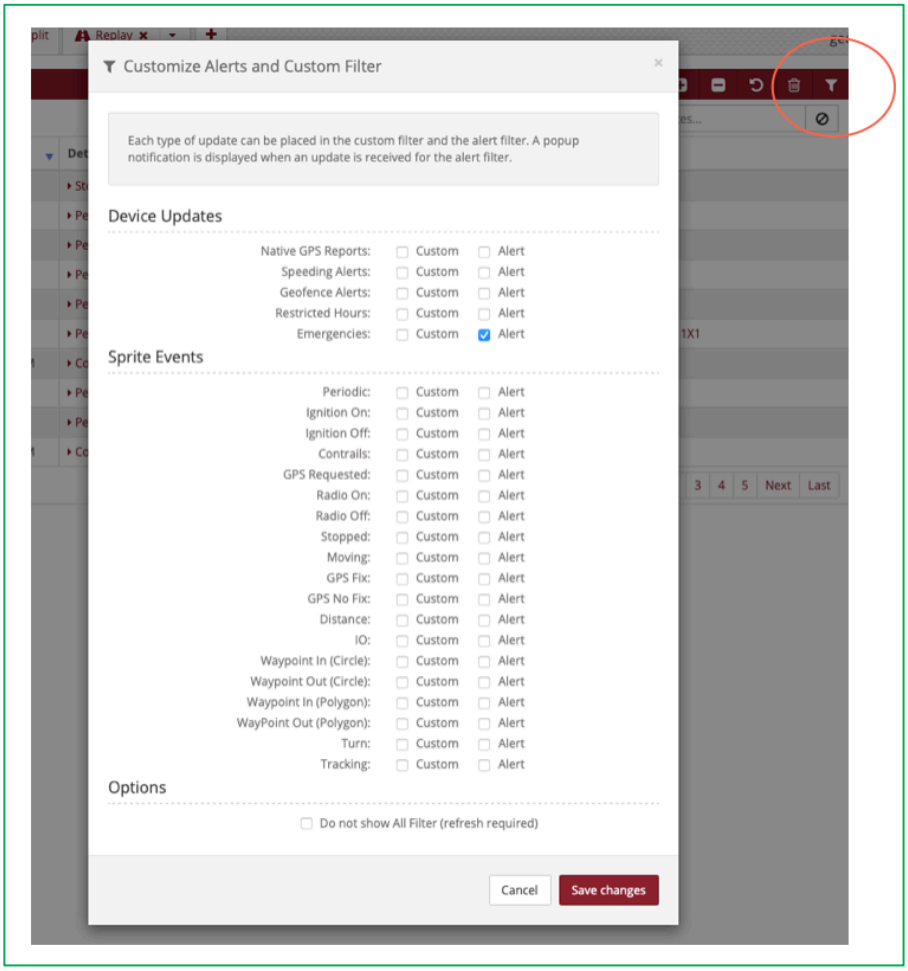
Contrails are special updates that can contain multiple positions and Events. It is a patented compression scheme that allows multiple geo-positions TW400 device events to be transmitted in one information update rather than several, therefore reducing the amount of data used. TALLYMATICS uses this capability to provide higher resolution tracking to enable proper performance verification and auditing. Clicking the Details column will expand to show the Events that occurred in the Contrail. Clicking the Type column will show the entire contrail on the map (typically 30+ GPS points).



3.3.3 Custom Updates and Alerts Filter

There are four filters that can be applied to the update table to specify which updates should be displayed:

- All: When this filter is selected, all updates are displayed.
- Custom: When this filter is selected, then only updates that match the user configured Custom filter are displayed. The Custom filter and Alert filter can be edited by clicking the "Customize Update Filters" button with the filter icon (see red circle in figure).
- Alert: When this filter is selected, then only updates that match the user configured Alerts filter are displayed. Additionally, when an update is received and matches the Alerts filter, then a sound alert is played and a notification is displayed until it is cleared by the user.
- Radio: When this filter is selected, then only the updates for the specified radio are displayed. This filter can be accessed by selecting "Show recent updates" from a radio command menu. Clicking the "Filter" icon will allow you to edit the reports for the custom and alert filters.

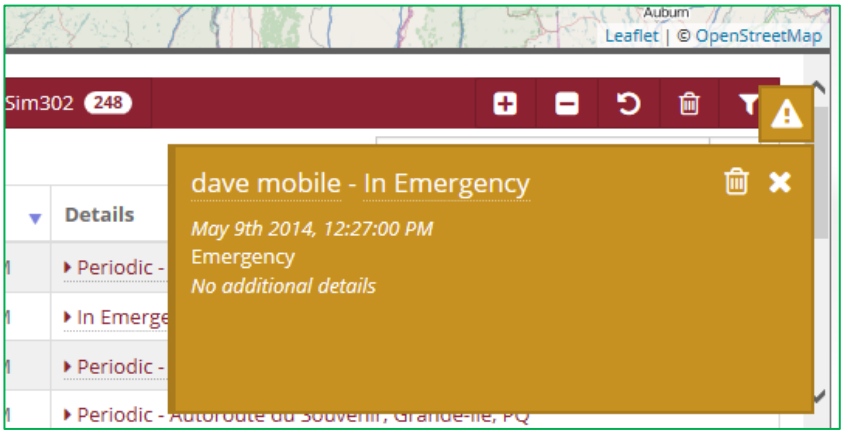


3.3.3.1 After Hours Usage

An important category of tracking and alert is After Hours Usage. TruFleet has a flexible mechanism for identifying multiple periods during the day which can be considered after hours usage. This activity can trigger an alert and be readily seen on the map display.

3.3.4 Alerts

When an update is received from the server that matches the alert filter, a notification is display on the screen along with a sound alert. The notification will remain on screen until it has been dismissed by the user.

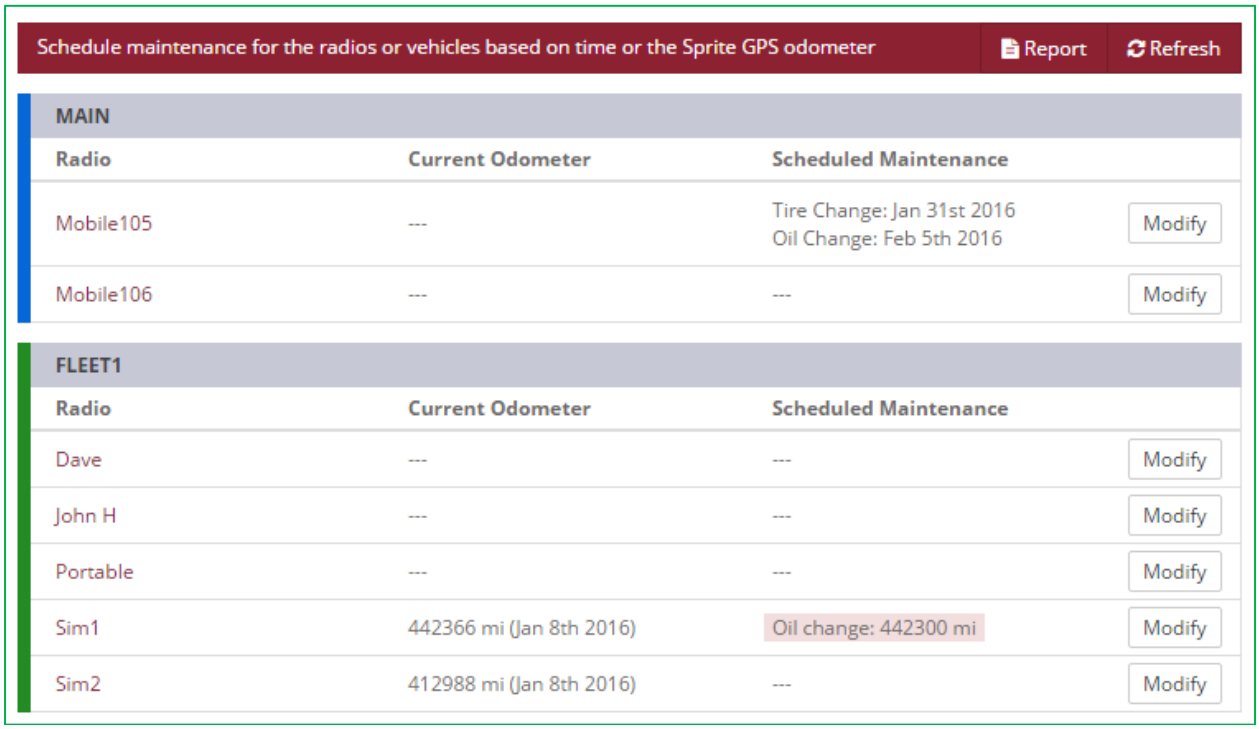


3.3.5 Split Tab

The split tab combines the Map tab and the Updates tab so they can both be viewed at the same time.

3.4 MAINTENANCE TAB

The Maintenance tab can be opened by clicking the "+" button to the right of the opened tabs. Maintenance appointments can be scheduled for each radio based on time or based on the vehicle odometer. If granted permission, you may click the "Modify" button to add, edit or remove appointments for a radio. A report can be generated which will summarize the overdue and upcoming maintenance appointments.



3.5 ROUTE REPLAY

A route replay will display where a radio was on a map during a specific time frame. It can be initiated through the Fleet Sidebar menu and selecting "Route Replay - Last hour / Last 24 hours / Today", or by selecting "Replay" at the top of the Fleet selecting a specific device and time frame.

Running a Route Replay displays a panel on the left of the screen that shows all GPS reports for the radio during the time frame, including the sequence number, type of report and a timestamp. Additionally, the green "speedometer" indicates that the radio was moving at the time - a red "speedometer" indicates that the radio was stopped at the time.

Clicking play will show the GPS reports in sequence with a breadcrumb trail. Clicking an update on the left will jump to that GPS position. Additional information for the current GPS report is displayed in the top right corner.

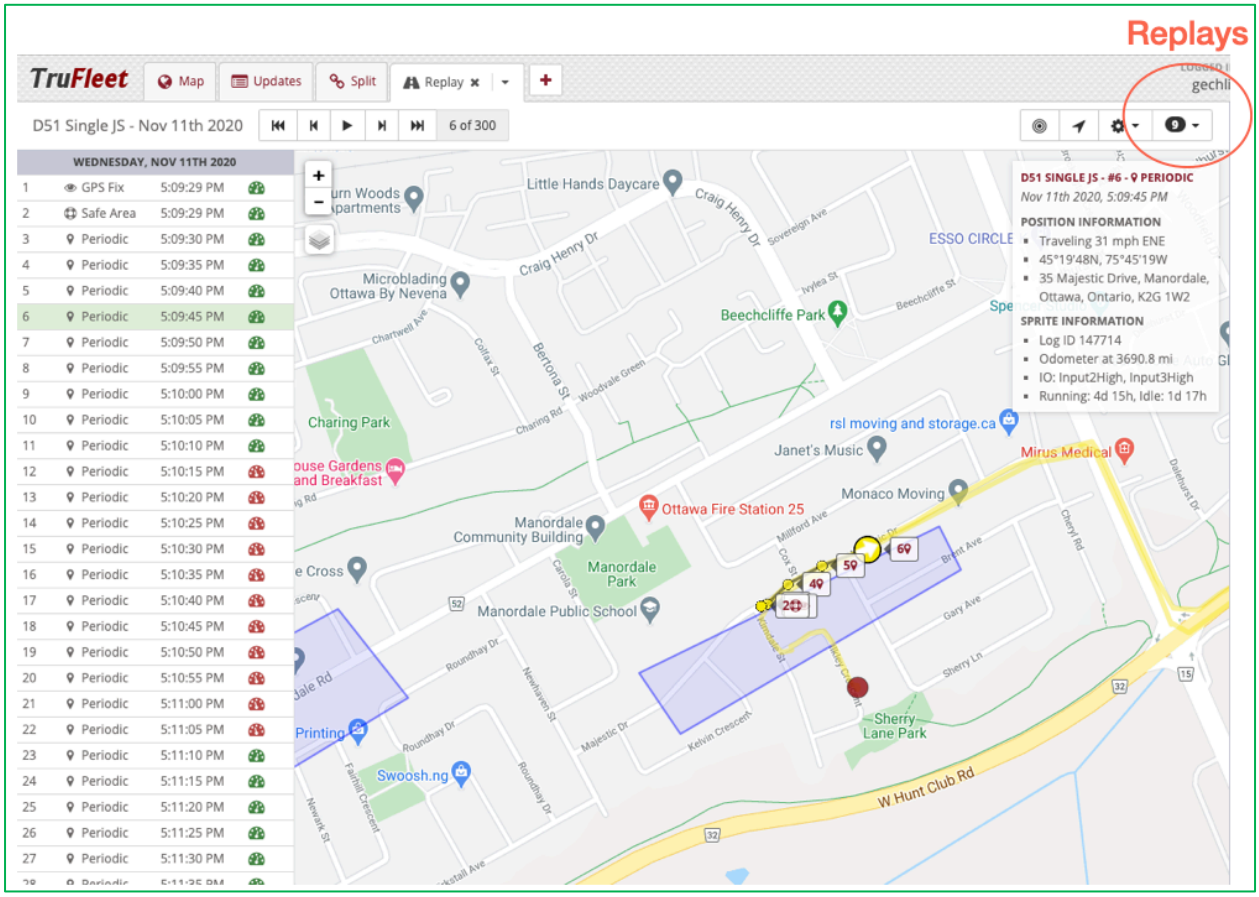


Figure 4: Replay Menu

When a new route replay is created, it will not delete the previous route replay. Clicking the "Replays" button will allow you to switch between all route replays that were requested.

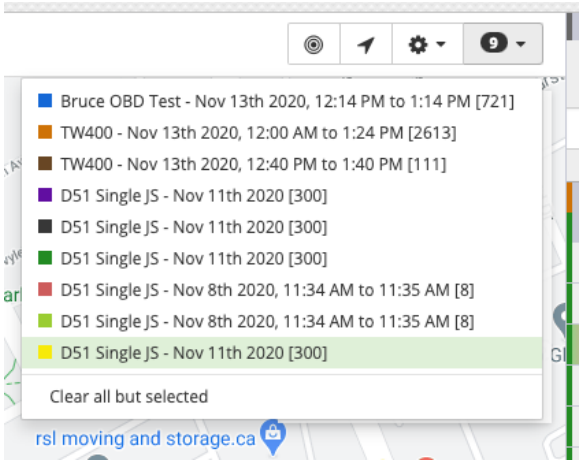


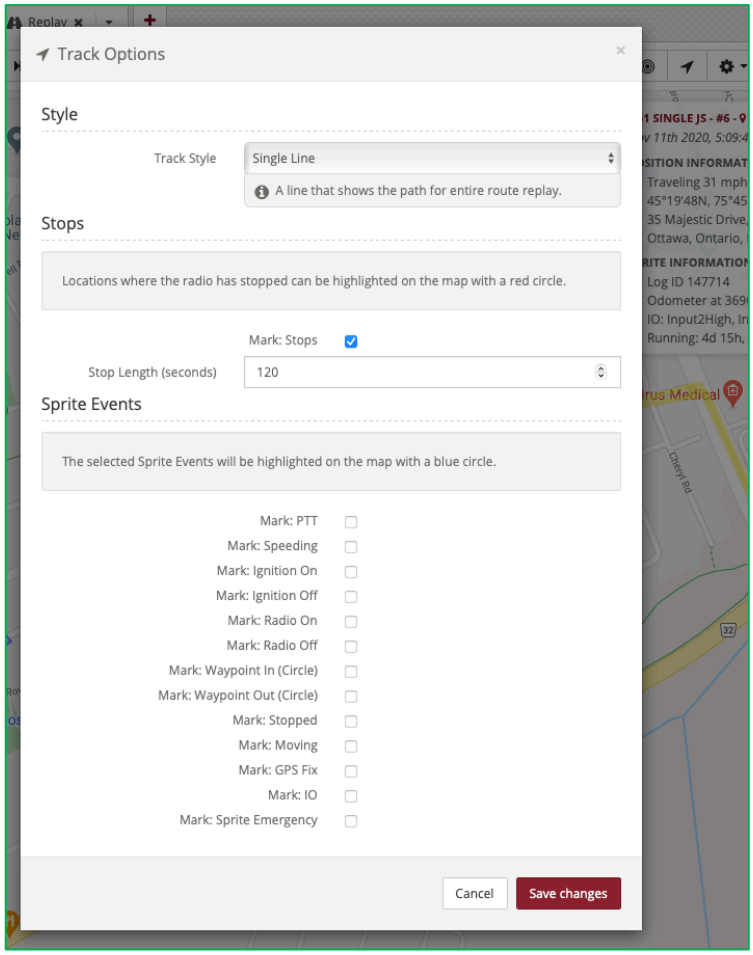
Figure 5: Replay Menu

3.5.1 Map Control Bar

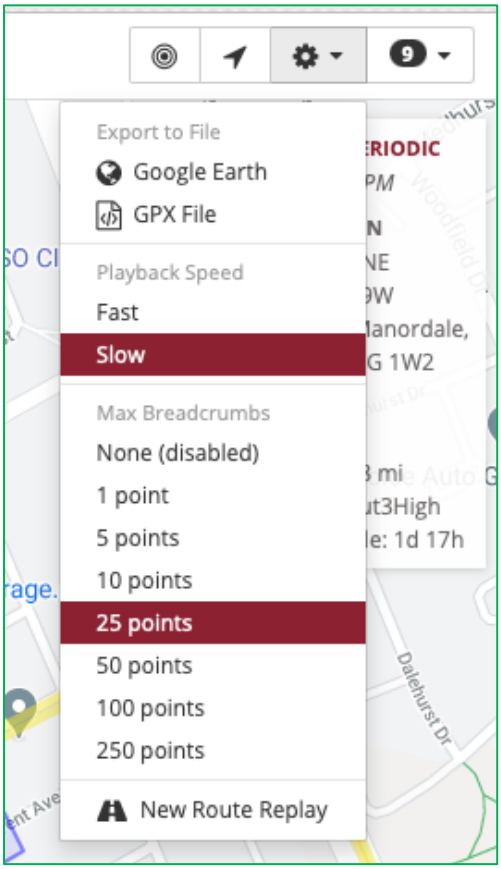
The Control Bar where the Route Replay instance selection described above is the the Map control bar. It has several other functions. The left most button that looks like a “bullseye” keeps the vehicle being replayed in the centre of the display. See the figure below (it is shaded).

The next button (an arrowhead) allows the breadcrumb trail to be modified and show various events that can be monitored in the TW400 hardware, such as:

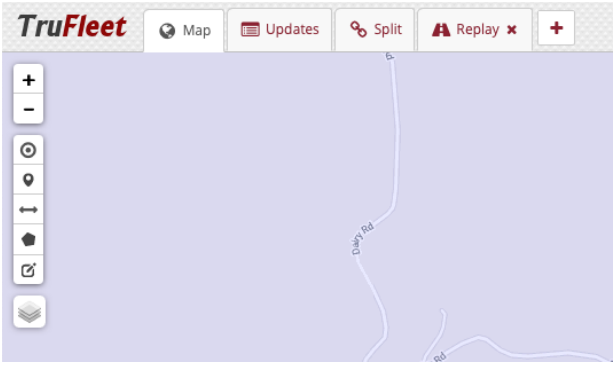
- exceeding a set speed,
- programmed Input state, e.g. plow up, plow down, 8 way flashing lights on/off, door open door/ closed, Power Take-Off on/off
- stops of a programmable duration
- Emergency



The last button, shaped like a gear, allows further modification of the replay, as well as export of the information to several industry standard formats (Google Earth and GPX). Playback can be set as fast or slow, and the number of breadcrumbs in the playback can be set. This is a shortcut to the same functionality that can be found in the overall settings menu.



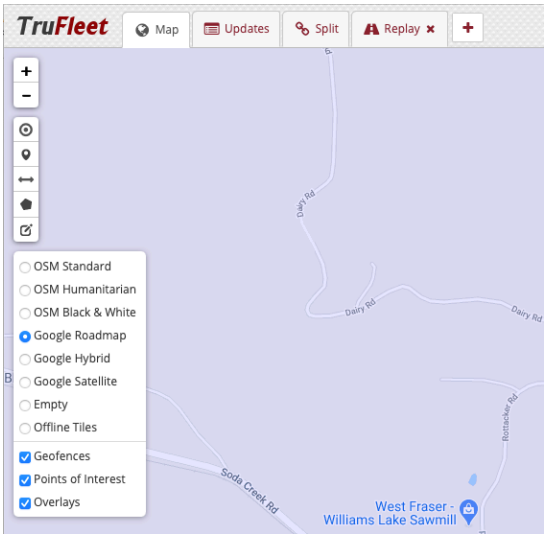
3.6 Focus Points and Tile Layers



In Map view, when not performing a route replay, there is a set of controls in the upper left portion of the display which allows you do the following:

- Zoom in (+) or Zoom out (-)
- Create a Geosearch
- Create a Point of Interest
- Measure a distance
- Create a GeoFence
- Edit a GeoFence
- Select a tile layer or style
- Turn on/off the display of GeoFences, Points of Interest and Overlays

GeoFences, GeoSearches and Points of Interest have have already been described. Tile layers allow for the selection of different mapping sets, including imported ESRI map layers in Shapefile format (for customer specific information). “Shrinkwrapped” map sets available are

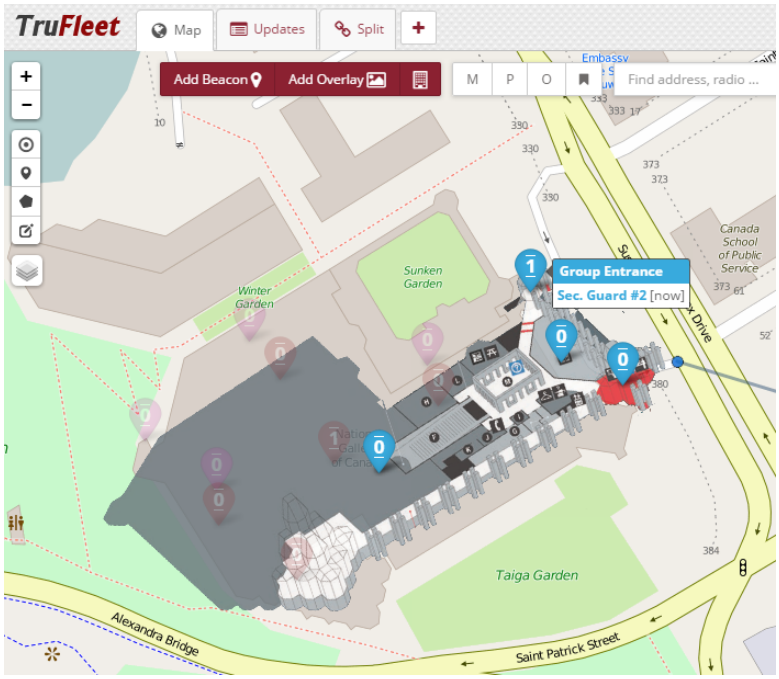


- OSM Standard
- OSM Humanitarian
- OSM Black and White
- Google Roadmap
- Google Hybrid
- Google Satellite

3.7 Indoor Features (for use with LMR Radios that support iBeacon)

The map tab allows beacons and overlays to be added, modified and deleted if the user has been granted access. To enable the indoor edit mode, click the button with the icon of a building.

Beacons are used for indoor location on supported radio networks. A beacon should be created in TruFleet for each iBeacon device that has been installed. The major and minor IDs must match those configured in the iBeacon device. Radios that report those major and minor IDs will appear on the map at the beacon.



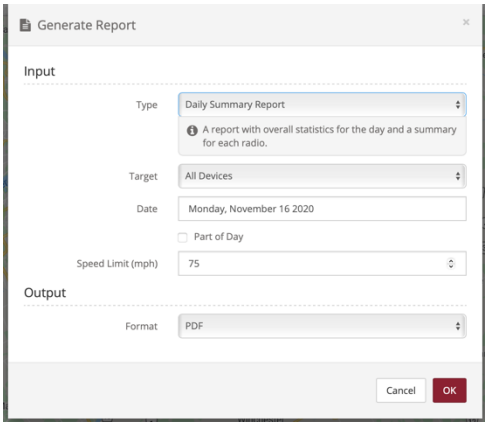
Overlays are images that can displayed on top of the mapping tiles. Typically, this can be used for indoor location by importing floorplans. It can also be used to provide extra detail that is not provided by the mapping tiles.

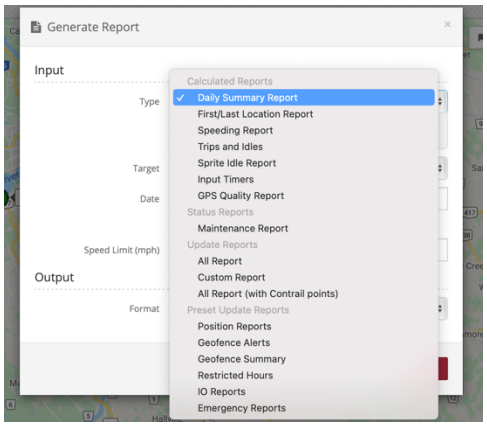
While in indoor edit mode, clicking on a beacon or overlay will display a menu to edit/delete/save changes/cancel changes. They can also be dragged to a new location and saved.

If a "Floor Level" is assigned to either a Beacon or an Overlay, then they will only be displayed if the selected floor is chosen. Otherwise, they will always be shown.

3.8 REPORTS

Clicking the "Report" icon at the top of the Fleet Sidebar will bring up a form to generate a report. The report will be either displayed in a new window or downloaded as a file depending on the output format and the browser settings. An email address can be specified to receive a copy of the report as well.





Reports are selected for an individual vehicle, a specific fleet or all vehicles and are selectable by a day, part of a day or by date range. Export formats are PDF, Excel or Word. TruFleet provides a comprehensive set of reports (examples appended to the back of this document), including:

3.8.1 Calculated Reports

3.8.1.1 Daily Summary Report

A report with overall statistics for the day and a summary for each radio.

3.8.1.2 First/Last Location Report

A report with the first and last location of radios on a daily basis.

3.8.1.3 Speeding Report

A report on all updates that were over the specified speed limit.

3.8.1.4 Trips and Idles

A report with a list of time intervals while the vehicle is moving (a trip) and while it is stopped for a period (idle).

3.8.1.5 Sprite Idle Report

A report that calculates how long a vehicle has been idling for. Requires a Sprite that reports the idle and run times.

3.8.1.6 Input Timers

A report that calculates how long digital inputs have been active for. Requires a Sprite that reports input timer data.

3.8.1.7 GPS Quality Report

A report that summarizes the GPS quality of a radio. Can be used to identify radios with problematic GPS reporting.

3.8.2 Status Reports

3.8.2.1 Maintenance Report

A report for scheduled maintenance for Sprite enabled vehicles.

3.8.3 Update Reports

3.8.3.1 All Report

A report with a list of all updates.

3.8.3.2 Custom Report

A report that includes only the update types specified and that (optionally) match the text filter.

3.8.3.3 All Report (with Contrail Points)

A report with a list of all updates. Contrail points are included in the report, which can make the report quite long.

3.8.4 Preset Update Reports

3.8.4.1 Position Reports

A report with a list of all position reports (GPS and Beacons).

3.8.4.2 Geofence Alerts

A report with a list of all geofence alerts.

3.8.4.3 Geofence Summary

A report that shows a summary of enters and exits for each geofence.

3.8.4.4 Restricted Hours

A report that shows a list of all restricted hours alerts.

3.8.4.5 I/O Reports

A report with a list of all IO reports.

3.8.4.6 Emergency Reports

A report with a list of all emergency reports.

4 TALLYMANAGER/TALLYBROKER CLOUD BASED DEVICE MANAGEMENT PORTAL

The TALLYMANAGER/TALLYBROKER portal is a cloud-based device management application which provides the following functionality for the TW400 telematics devices:

- Activation/Deactivation of cellular service. This enables devices to be temporarily offline and not incurring cellular service charges. This particularly important in a seasonal fleet.
- Configuration of I/O, reporting behaviour and other resources in the TW400. The TW400 is an extremely flexible product with many inputs, outputs and onboard resources that can be

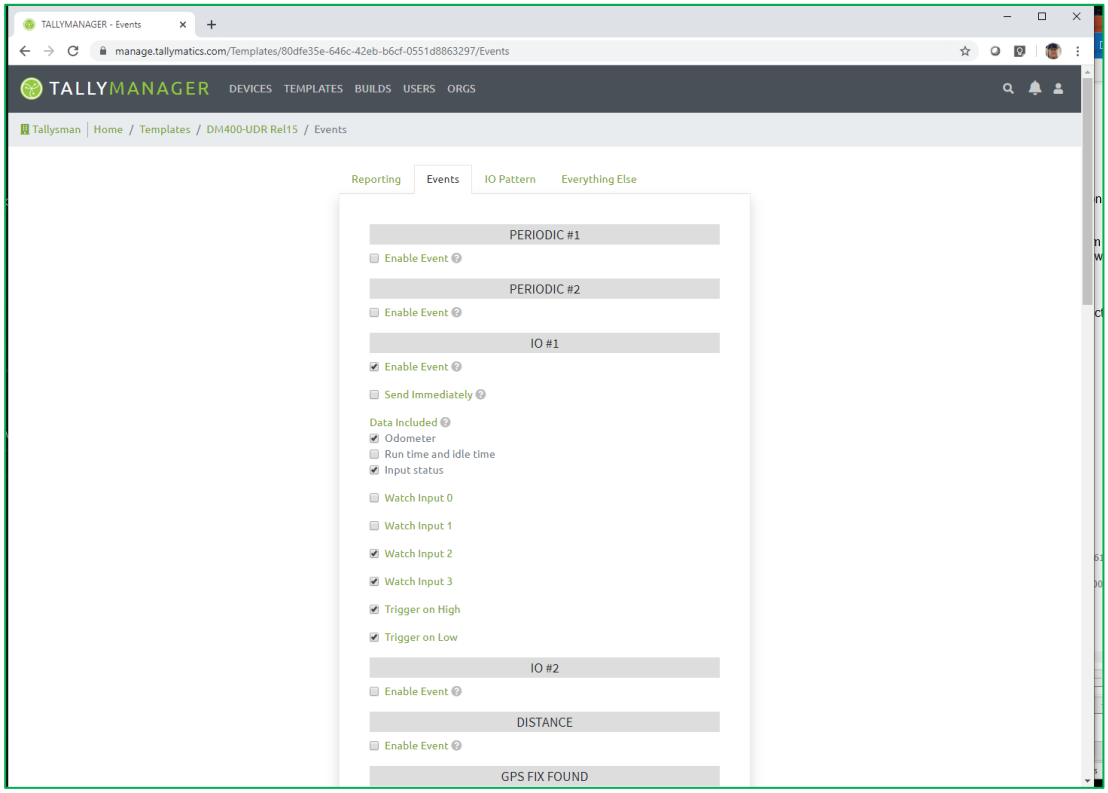
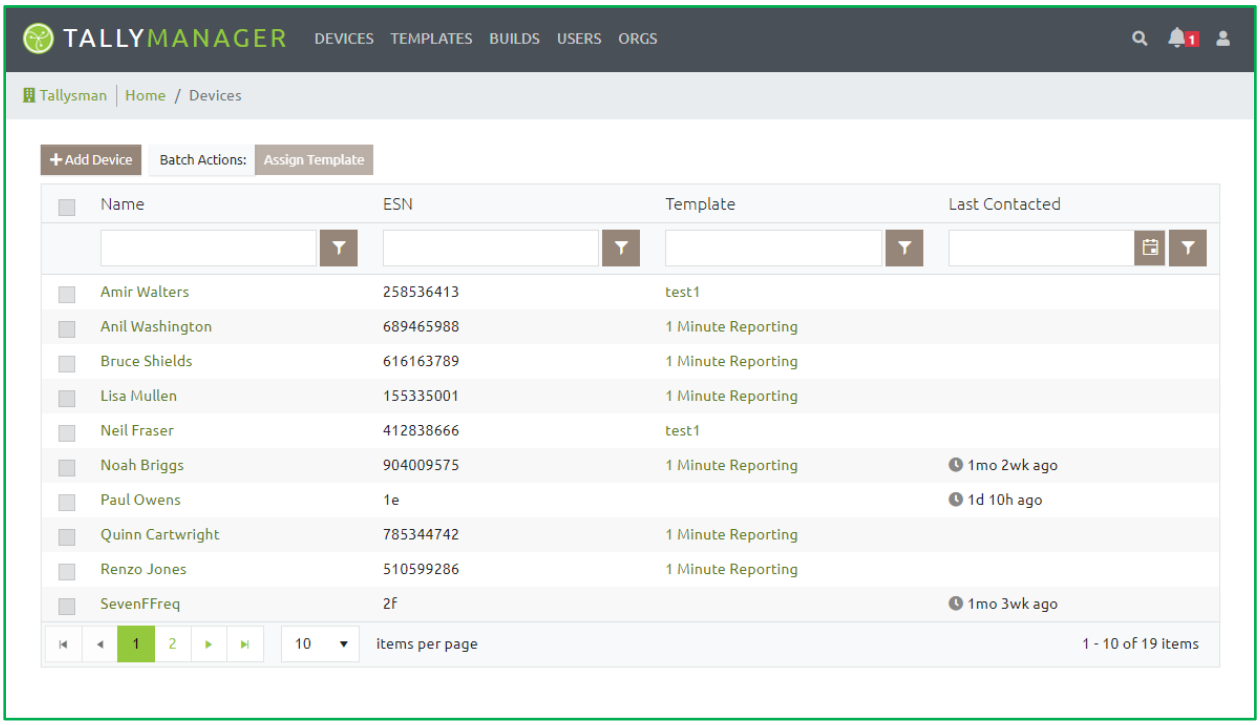


Figure 6: Event pallet

combined to generate events which are promulgated to the TruFleet AVL app, or made available on the TALLYBROKER 3rd Party API. TALLYMANAGER provides a flexible pallet of choices to configure each device. Reporting is also flexible, allowing the recording interval to be changed, as well as the reporting interval.

- Template application. TW400 configuration is dependent on the type of application. A library of customized templates can be created, and applied at the device level, or at the fleet level.
- Over the Air Updates. As new firmware is available to improve the TW400, either with better performance or new features, TALLYMANAGER manages the firmware loads, as well as configuration updates to the devices. New firmware revisions and configurations can be applied as the TW400 operates in the vehicle.



4.1 TALLYBROKER

The TALLYBROKER is a cloud-based portal that provides an address for each vehicle that a 3rd party application can use to access the information that the TW400 provides. The standard API is a RESTful/JSON interface, which is an standard interface that can be quickly adapted for most applications. TALLYMATICS will develop an API for major standards and applications on request.

5 THE SPRITE TW400 LTE-M TRACKER

The in-vehicle component of TALLYMATICS AVL solution is the Sprite TW400 LTE-M tracker. This is a modern, premium featured telematics device that provides a flexible and economical solution for many different in-vehicle applications.

The major features of the TW400 enable the following benefits:

5.1 Robust, low cost cellular transmission using the LTE-M cellular network.

LTE-M is intended to be used for lower bandwidth information. Its better transmission characteristics allows the device to be installed in a vehicle without requiring external antennas while still delivering great performance.

5.2 Highly accurate Geo-positioning

The TW400 achieves very accurate Geo-Positioning using an integrated high performance multi-constellation Global Navigation Satellite System antenna and receiver. Accurate geolocation has not always been the strength of all telematics products, with an estimated location being generally acceptable to date. Many applications however require auditable, verifiable proof of performance, such as deployment of de-icing material in snowy conditions. Other factors such as multi-path interference (GNSS signals bouncing off of buildings) can cause problems. The GNSS antenna in the TW400 can track 4 different navigation satellite systems, and form an accurate fix using the best signal out of 3.

5.3 Verifiable Audits of task performance

TW400 achieves 12x geo-point accuracy over competitive system via Contrails proprietary lossless Data Compression. Highly accurate antennas are only one part of the equation when it comes to having accurate information to verify proper performance of a work task. The other half of the requirement is to ensure that there is a high enough density of geopoints reported to properly ascertain the vehicle was or was not at a specific location, performing the necessary task. Many telematics solutions don't report

enough information as they are trying to conserve data to keep monthly service costs down. All of TALLYMATICS' telematics devices use a proprietary and patented data compression algorithm called Contrails that reduces the amount of data consumed, while simultaneously achieving frequent updates. The usual reporting configuration for TW400's is to record a geopoint location every 5 seconds, and report 12 points every minute (1 minute 1 sample is typical of other systems). This delivers great information density, while minimizing network overhead and therefore minimizing data use.

5.3.1 Lossless

The Sprite protocol adds an extra layer of reliability to the system by ensuring that even if a data point or packet is somehow missed through network loss, the TW400 has a record of the information and between the Cloud applications and the TW400, the missing information is identified and restored the next time the TW400 reports. This process will continue until all data is recovered.

5.3.2 On board data storage for out of service area operation.

There is a possibility that a vehicle may drive out of cellular reception range for a short or even extended period of time. The TW400 has a significant amount of on-board memory, which will allow for a typical vehicle to be out of range for between 2 weeks and 1 month, while preserving all of its recorded data.

5.4 MONITOR CRITICAL VEHICLE SYSTEMS TO EFFECTIVELY MAINTAIN VEHICLES

The TW400 provides On-Board Diagnostics Support. The use of the internal Engine Computing Module (ECM) information in vehicles is essential to detect Malfunction Indicator Lamp status and warn of impending problems. It is also useful in monitoring key systems when the information is available e.g. Power Take Off status

5.5 INTERFACE TO VEHICLE PAYLOADS, E.G. MATERIAL SPREADERS

The TW400 incorporates 2 serial buses to interface to onboard application payload systems, including sophisticated add-on equipment such as **material spreaders**, via CANBus or Serial Bus (RS-232). The TW400 can be procured with either 2 RS-232 serial buses, or a CANBus and an RS-232 serial bus. CANBus is typically used for the vehicle OBD bus. Material Spreaders such as those used by public works fleet snow plows in the winter commonly us RS-232 to communicate information about how much material is deposited and when to external systems. Monitor and control ancillary vehicle equipment with 4 digital inputs and 3 Digital outputs.

Many specialty fleets have equipment is very useful to monitor or control by sensing a digital input, or turning on a relay with a digital output. Examples are:

- School Bus Crossing Gate
- Door open/close
- School bus 8 way lights activated/deactivated
- Power Take Off activated/deactivated
- Plow up/Plow Down

5.5.1 Untethered Dead Reckoning for improved accuracy in Deep Urban Canyons

One benefit of the serial bus available on the TW400 is the ability to capitalize on the capabilities of TALLYMATICS' TW5X62 smart antenna with Untethered Dead Reckoning. In an environment where

there is a lot of surface reflection, such as the “Deep Urban Canyons” typical of major city centres, GNSS performance can be very poor. TALLYMATICS’ TW5X62 is a multi-constellation GNSS Receiver/Antenna fused with inertial sensor data, which allows it to filter out extraneous information and incorporate inertial information in its GNSS fix. When you want to know whether a vehicle is in the middle lane or on the sidewalk in downtown Manhattan, Chicago, Toronto, Montreal, or London, this is the answer.

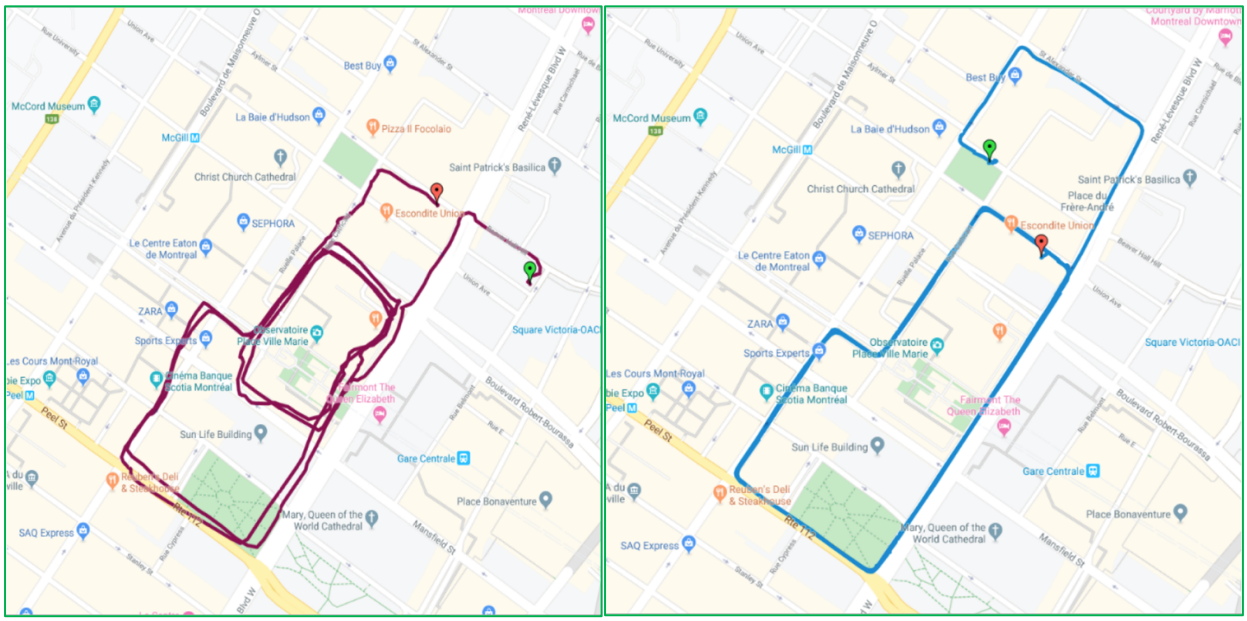
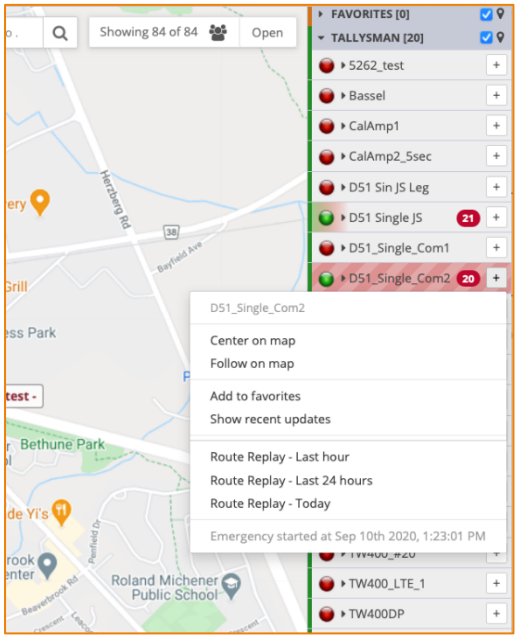


Figure 7: Left: No UDR, Competitor. Right: TW400 w UDR

5.6 Emergency Button.

The TruFleet AVL solution implements an “out of the box” emergency button for drivers to press if they feel that they are in peril. This is a prepackaged use of a digital input, which utilized an alarm button, a minimum depression of the button, and sends an alert via TruFleet. The alert can be cleared by a properly authorized administrator.



5.7 Manage Driver ID

The TW400 has several ways to capture driver ID. The simplest and least expensive way is using the built-in 1wire MicroLan bus that allows for the use of iButton Fobs or rings. Another methodology used by the TW400 for Driver ID and asset management in the future will be the addition of a Bluetooth transceiver and Bluetooth Beacons. This functionality will be available mid-2021, and is intended to be a simple add on to the RS-232 bus.

6 REPORT EXAMPLES