Title: AIR TANKER INFORMATION SYSTEM

Abstract: The present technology provides a system and method for tracking payload drops from aircraft. The method includes initiating a payload drop, accurately determining the start of the drop and the end of a drop, determining a drop vector, and relating the data to geographical locations. The payload carrier information system comprises at least one sensor to report payload status prior to a drop, at the start of the drop and, at the minimum, at the end of the drop, a payload controller, a sensor data collector, a display unit operably linked to the sensor data collector, and a communication manager comprising satellite telemetry, and tracking.

FIG. 1
MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG). Published: — with international search report (Art. 21(3))
AIR TANKER INFORMATION SYSTEM

BACKGROUND OF THE INVENTION

Field of the Invention

The present technology relates to tracking and reporting air tanker activities. More specifically, the present technology relates to a system and method for tracking and reporting load and dump data for air tankers and aircraft carrying hooked payloads.

Description of the Related Art

Aircraft are used extensively for lifting, transporting and dropping loads, such as water, foam, other fire suppressors, logs and the like. In the case of fire-fighting, knowing pick-up (fill and load) information as well as the vector of a given drop and therefore being able to estimate the ground coverage of a given drop is far more useful than simply knowing the starting point of a given drop. If a load of fire suppressant is dumped, the suppressant volume, the chemical type/composition/mass, the rate at which it is dumped, the groundspeed/airspeed and the altitude will all factor in to determining the area covered. This cannot be determined on the basis of a start point of a given drop alone.

Another aspect of tracking is for environmental protection. A carefully executed dump may avoid private properties, streams and the like, whereas a poorly executed dump may foul private land or waterways. Unfortunately, systems currently in use report a "drop" as a single point on a map along with some descriptive parameters that are calculated by the hardware in the aircraft.

Another aspect is the addition of collecting meteorological data including but not limited to readings of air temperature and relative humidity, simultaneous to a drop. This provides an aid to fire and fuel management research and helps those agencies analyze the field deployed effectiveness of various drop methods and types of chemical suppressant used.

Tracking systems have the potential to change how air tanker, logging companies and the like measure and manage their fleets, whether fixed wing or helicopter. A system and method for drop tracking that reports on both the beginning and endpoints of a drop, volume monitoring and other payload/spatial/situational details and relaying the data collected to a web-based
mapping and data management service in real-time would provide a significant improvement to the industry.

SUMMARY OF THE INVENTION

In general, the exemplary method and system provide for tracking payload drops from aircraft. It includes the system for executing the method, wherein the method includes initiating a payload drop, accurately determining the start of the drop and the end of a drop, determining a drop vector, and relating the data to geographical locations, thereby providing a significant improvement over systems and methods that simply report the start of a drop.

In one embodiment a method for tracking a payload drop from aircraft is provided, the method comprising: sensing the readiness of a drop; sensing the beginning of the drop; relating the beginning of the drop to a first geographical location to provide a first data point; sensing the end of the drop; relating the end of the drop to a second geographical location to provide a second data point; determining a vector between the first and second data points; and reporting the beginning, end and vector of the drop, thereby tracking the payload drop. The sensing is effected by a door position sensor or a load sensor or a fluid level sensor.

The method further comprises collecting data points at a plurality of geographical locations throughout the drop and optionally sensing at the plurality of geographical locations. Additionally, raw data are collected. Thereafter, the data points and raw data are relayed to a base station in real-time, where it is analyzed. The data may be analyzed after the mission is completed, or otherwise. Web-based mapping and data management are used to analyze the data. This method is applicable to both helicopters and fixed wing aircraft.

In another embodiment a payload carrier information system for use in an aircraft is provided, the system comprising at least one signaler configured to report payload status prior to a drop, at the start of the drop and, at a minimum, at the end of the drop, a payload controller, a signaler data collector, a display unit operably linked to the sensor data collector, and a communication manager comprising satellite telemetry, and tracking.

In the system the at least one signaler is configured to provide at least one of load weight, tank volume, fill or injector pump flow, time on of fill switches, and payload door status.

In the system the signaler may be a load cell or it may be a door position sensor.
The system may further comprise an onboard satellite communication device for communicating with a base station.

In the system the onboard satellite communication device includes voice, messaging, flight tracking and data communication or messaging, flight tracking and data communication.

In the system the payload controller may be a bucket control unit or may be a door control unit.

In the system the aircraft may be a helicopter or a fixed wing aircraft or a balloon airship.

In another embodiment a payload carrier data collection and analysis system for use with an air tanker is provided, the air tanker having at least one tank with at least one sensor to report payload status at the start of the drop and at the end of the drop and a payload controller, the payload carrier data collection and analysis system comprising an onboard sensor data collector, an onboard communication manager comprising satellite telemetry, and tracking, an onboard satellite communication device and a base station, the base station comprising a processor configured to analyze the data to provide a drop vector.

In yet another embodiment a method for tracking a payload load and drop event from an aircraft is provided, the method comprising:

receiving data on a load being loaded;

optionally, receiving data reporting sensing the readiness of a drop;

receiving data reporting sensing the beginning of the drop;

receiving data reporting sensing the end of the drop;

relating the beginning of the drop to a first geographical location to provide a first data point;

relating the end of the drop to a second geographical location to provide a second data point;

determining a vector between the first and second data points; and

reporting the beginning, end and vector of the drop, thereby tracking the payload drop.

The method further comprises collecting data points at a plurality of geographical locations throughout the drop and optionally receiving data reporting sensing at the plurality of geographical locations.

The method further comprises collecting raw data.

The method further comprises relaying the data points and raw data to a base station in real-time.

The method further comprises analyzing the data after a mission is completed.
The method further comprises utilizing web-based mapping and data management to analyze the data.

In the method the data on the load includes a type of load, and one or more of a volume and a weight of the load.

In the method the data on the load includes a location and a loading time.

In yet another embodiment an operational loads management system for use with an aircraft is provided, the system comprising: an at least one onboard signaler configured to report payload status including load, start of a drop and end of a drop; an onboard payload controller; an onboard signaler data collector; an onboard communication manager including satellite telemetry, and tracking; an onboard internal inertial measurement unit (IMU); and an onboard pitot-static system.

The operational loads management system further comprises an onboard satellite communication device.

In the system the onboard satellite communication device includes voice, messaging, flight tracking and data communication or messaging, flight tracking and data communication.

The operational loads management system further comprises a base station, the base station having a processor configured to analyze the communicated data.

**BRIEF DESCRIPTION OF THE DRAWINGS**

Figure 1 is a block diagram of the system of the present technology.

Figure 2 is a block diagram of the communication protocol of the present technology.

Figure 3 is a block diagram of the Operational Loads Management of the present technology.

Figure 4 is a block diagram of the communication protocol including Operation Loads Management of the present technology.

**DESCRIPTIONS OF THE PREFERRED EMBODIMENTS**

Except as otherwise expressly provided, the following rules of interpretation apply to this specification (written description, claims and drawings): (a) all words used herein shall be construed to be of such gender or number (singular or plural) as the circumstances require; (b) the singular terms "a", "an", and "the", as used in the specification and the appended claims
include plural references unless the context clearly dictates otherwise; (c) the antecedent term "about" applied to a recited range or value denotes an approximation within the deviation in the range or value known or expected in the art from the measurements method; (d) the words "herein", "hereby", "hereof", "hereto", "hereinbefore", and "hereinafter", and words of similar import, refer to this specification in its entirety and not to any particular paragraph, claim or other subdivision, unless otherwise specified; (e) descriptive headings are for convenience only and shall not control or affect the meaning or construction of any part of the specification; and (f) "or" and "any" are not exclusive and "include" and "including" are not limiting. Further, The terms "comprising," "having," "including," and "containing" are to be construed as open-ended terms (i.e., meaning "including, but not limited to, ") unless otherwise noted.

To the extent necessary to provide descriptive support, the subject matter and/or text of the appended claims is incorporated herein by reference in their entirety.

Recitation of ranges of values herein are merely intended to serve as a shorthand method of referring individually to each separate value falling within the range, unless otherwise indicated herein, and each separate value is incorporated into the specification as if it were individually recited herein. Where a specific range of values is provided, it is understood that each intervening value, to the tenth of the unit of the lower limit unless the context clearly dictates otherwise, between the upper and lower limit of that range and any other stated or intervening value in that stated range, is included therein. All smaller sub ranges are also included. The upper and lower limits of these smaller ranges are also included therein, subject to any specifically excluded limit in the stated range.

Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the relevant art. Although any methods and materials similar or equivalent to those described herein can also be used, the acceptable methods and materials are now described.

Definitions:
Load and Drop event: In the context of the present technology, a load and drop event starts with any load being loaded, then lifted or carried and dropped or placed. Both the beginning and end of the drop are tracked.
Drop or Dump event: In the context of the present technology, a drop or dump event starts with the beginning of the drop or dump and proceeds to the end of the drop or dump. There is a starting point and an end point from which a drop or dump vector can be calculated.

Signal: In the context of the present technology, a signaler is an onboard device that includes sensors, switches, manually actuated triggers, feedback signalers and manually controlled input devices that can be used to track a load and drop event or just a drop event.

Description:

A web-based system (Air Tanker Information System™ [ATIS]) to track tanker pickups and drops and relay the information in real time, generally referred to as ATIS is shown in Figure 1. The technology is equally suited for internal or external tanks on fixed wing aircraft or helicopters, for example, belly tank systems, bucket systems, and dual tank systems. In addition, it is applicable to heli-logging and other applications where loads are lifted, carried, and then released.

The system 10 has a hardware component 12 that includes a wide range of signalers for use in tracking a load and drop event, including: sensors for measuring all or a portion of weights, tank volumes, fill or injector pump flow, temperature, and humidity, including, but not limited to, a load cell 16 or other suitable strain gauge sensors; and/or time on of fill switches 18; a fluid flow sensor 20; a temperature sensor 11; an ambient humidity sensor 24; a fluid pressure sensor 26; a fluid level sensor 28; discrete signals (relay outputs 30, manually actuated triggers 32, mechanical buttons/switches, including door limit switches 34, hydraulic feedback signals 36, landing gear squat switches 38, speed brake switches 40, manual input device for inputting load type 42, which can be, for example, but not limited to, logs, equipment, lumber, water, gel, foam or retardant), a radio altimeter 44, an angle of attack sensor 45, a flap position sensor 46, a door or valve state sensor 47, a drop trigger switch 48 and a cabin pressure sensor 49, a display unit 50, a payload controller 52, a signaler data collector 54 having extensive onboard memory, data capture and initial computation (i.e. determination of events and required actions), a communication manager 56 having satellite telemetry or having access to satellite telemetry 58, tracking 60 and a messaging transceiver 62, to transfer data to the ground in near real-time and an optional onboard satellite communication device 64. The onboard satellite communication device 64 communicates with a satellite 66, which in turn transmits via a satellite network 68 either directly to the base station 70 or via the internet 71 to the ATIS interface 74 on the
recipient device (processor at the base station) 70 or to a cloud 72 and then the base station 70, where the data are monitored and analyzed using the processor 76 for web-based mapping, data storage and data management.

The signaler data collector 54 and the communication manager 56 may be provided as a single unit.

The base station 70 also provides a secure user interface and data visualization. The data may be overlaid onto a mapping display, which for example, but not limited to, may be a web-based map.

The drop "event" is captured by the aircraft mounted device, typically the sensor data collector 54 but can also be the onboard satellite communications device 64 that supports messaging, flight tracking and data communication. The details of the event are displayed and further information derived/calculated when the data get to the ground web-based server system 74 at the base station 70. The details of the event can also be displayed in the flight following website 78 on web-based maps 80.

In one exemplary embodiment, the payload controller 52 is a bucket control unit. In another embodiment, there is an onboard satellite communication device 64 and the onboard satellite communications device 64 includes voice, messaging, flight tracking and data communication or messaging, flight tracking and data communication.

The system is configured to report on both the beginning and endpoints of a drop. It also includes all the raw data along with data for a drop start and data for a drop stop. It is also configured to monitor volume. Therefore the system is configured to produce "true" data that has no opportunity for manipulation (accidental or intentional) by the aircraft operator. Final data adjustments and the outcome summary information are therefore transparent to all key data stakeholders.

The system operates as follows as shown in Figure 2:

A drop event occurs 100. When a drop event is determined to have occurred, signalers 14 feed 101 data to the sensor data collector 54, the sensor data collector 54 senses 102 that a drop event has occurred, this is then identified 103 by the firmware in the communications manager 56 which then sends 104 a payload data message to the processor 76 at the base station 70. This payload data message is designed to be as flexible as possible - there is a payload data content control byte that describes what type of message it is and therefore how it should be processed as
well as some other flags to indicate whether the message is intended to be forwarded on to any third party emails. Once the server of the base station 70 determines 106 that the stream contains data then it is processed 108 as a series of key value pairs to define the field. These are repeated for whatever number of data fields are available. The server looks up 110 the definition for these various fields and then applies any necessary translations to convert 112 them to display values. This means the system is completely configurable and extensible as to inputs - they are defined as needed.

Once a display data pack is in the database it is used in a few different ways. The first is to display 114 the drop inside the flight following website 78 in near real time for situational awareness and real time mission planning. Like other events, it is highlighted on the map and a site user can view 116 the various payload values. This same display data pack is also displayed 118 on a three dimensional web-based map 80 and can be downloaded 120 in a different format, for example, but not limited to, comma-separated values (CSV) flat files.

The processed data can also be sent 122 to a dedicated Airtanker Information System (ATIS) website 74. This site is for post processing 124 and analysis 126 of the data. The user can, for example, but not limited to, configure 128 various costs against an aircraft (daily rates, retardant types...) and then select 130 a time period for analysis. The site then looks 132 through the payload data for that aircraft and calculates 134 and maps 136 summary statistics for the time period. This may include some data such as the number of drops, the total volume dropped, the hours and distance flown. These statistics in combination with the cost inputs are also used to generate 138 some Key Performance Indicators (KPIs) including drops/hour, gallons/hour, gallons/drop and miles per run - all indications of the operational efficiency of the aircraft in that specific instance. Some aircraft are better suited to some types and locations of fires and sources of suppressant/retardant types (such as, but not limited to gels, water foam and retardants) and this website helps determine 140 what was most cost and operationally effective. The website 74 also provides a summary table of drop data for the time period with colour coded rows and icons based on retardant type. The report data can be exported 142 to any or all of CSV 86, the web-based map or the client, including forest agencies, via the industry standard data interchange.

The data can also be viewed by aircraft personnel as follows: The aircraft personnel connects 144 via a broadband internet connection 71 to the ATIS website 74 or the flight following
website78 and views 146 load and drop events or drop events for their aircraft or another aircraft.

The data can also be sent to other stakeholders as follows: The processor 76 reformats 148 the data and broadcasts 149 the data for despatch to, for example, but not limited to ground fire fighting personnel, hikers, environmental protection groups, and other aircraft.

The system may also comprise Operational Loads Management (OLM). OLM provides Flight Data Monitoring (FDM) and Engine Control Trend Monitoring (ECTM) processes in addition to the above described ATIS capabilities.

As shown in Figure 3, it involves the addition of:

- an internal IMU 82 (inertial measurement unit, comprised of a 3-axis magnetometer, a 3-axis accelerometer, and a 3-axis gyroscope) to capture AHRS (attitude, heading reference system) data,
  - Pitot/static inputs 84 to capture barometric altitude and airspeed
  - Arinc-573/7 17 receive channel 86 to capture any/all available FDR/FDAU/MAU (flight data recorder/flight data acquisition unit/modular avionics unit) data
  - Arinc-429 receive channels 88 (2) to capture any/all available ADC (air data computer) data on the attached Arinc-429 busses
- Additional data capture enabled by the above system description includes:
  - Aircraft inertial load factors
  - Aircraft VSI (vertical speed indication)
  - Aircraft attitude (pitch, roll, yaw, as well as rates)
  - IAS (indicated air speed)
  - Aircraft engine state
  - Extensive strain gauge capture
- Aircraft control surfaces (flaps, speed brake, etc.)

Using both the ATIS and OLM system allows for tracking loading, transporting and dropping as shown in Figure 4 (note that the OLM system is not necessary for tracking the loading and this could equally well have been presented in Figure 2):

The system is tracking and reporting load and dump data. A load event occurs 150. When a load event is determined to have occurred, signalers feed data to the sensor data collector
This includes, but is not limited to inputs 154A from the operator (load type), time 154B, location 154C, weight and/or volume 154D. The sensor data collector 54 senses 156 that a load event has occurred, this is then identified 158 by the firmware in the communications manager 56 which then sends 160 a payload data message to the processor 76 at the base station 70.

The load is then transported 180 to the drop site. The Flight Data Monitoring (FDM) and Engine Control Trend Monitoring (ECTM) data are recorded 182 and sent 184 to the flight following website where they are processed 190 and displayed 192 inside the flight following website 78 in near real time for situational awareness and real time mission planning. It is highlighted on the map and a website user can view 194 the progress. This same data are also displayed 196 on a three dimensional web-based map 80 and can be downloaded 198 in a different format, for example, but not limited to, comma-separated values (CSV) flat files. The processed data can also be sent 199 to a dedicated Airtanker Information System (ATIS) website 74.

The drop event then occurs 200. When a drop event is determined to have occurred, signalers 14 feed 201 data to the sensor data collector 54, the sensor data collector 54 senses 202 that a drop event has occurred, this is then identified 203 by the firmware in the communications manager 56 which then sends 204 a payload data message to the processor 76 at the base station 70. Both the start and end of the drop are sensed.

Once the server of the base station 70 determines 161 that the stream contains data then it is processed 162 as a series of key value pairs to define the field. These are repeated for whatever number of data fields are available. The server looks up 163 the definition for these various fields and then applies any necessary translations to convert 164 them to display values. This means the system is completely configurable and extensible as to inputs - they are defined as needed.

Once a display data pack is in the database it is used in a few different ways. The first is to display 166 the drop inside the flight following website 78 in near real time for situational awareness and real time mission planning. Like other events, it is highlighted on the map and a site user can view the various payload values. This same display data pack is also displayed 168 on a three dimensional web-based map 80 and can be downloaded 170 in a different format, for example, but not limited to, comma-separated values (CSV) flat files.
The processed data can also be sent to a dedicated Airtanker Information System (ATIS) website. This site is for post processing and analysis of the data. The user can, for example, but not limited to, configure various costs against an aircraft (daily rates, retardant types...) and then select a time period for analysis. It may also include data such as the hours and distance flown and stresses and strains on the aircraft.

The site then looks through the payload data for that aircraft and calculates and maps summary statistics for the time period. This may include some data such as the number of drops, the total volume dropped, the hours and distance flown. These statistics in combination with the cost inputs are also used to generate some Key Performance Indicators (KPIs) including drops/hour, gallons/hour, gallons/drop and miles per run - all indications of the operational efficiency of the aircraft in that specific instance. Some aircraft are better suited to some types and locations of fires and sources of suppressant/retardant types (such as, but not limited to gels, water foam and retardants) and this website helps determine what was most cost and operationally effective. The website also provides a summary table of drop data for the time period with colour coded rows and icons based on retardant type. The report data can be exported to any or all of CSV, the web-based map or the client, including forest agencies, via the industry standard data interchange.

The data can also be viewed by aircraft personnel as follows: The aircraft personnel connects via a broadband internet connection to the ATIS website or the flight following website and views load and drop events or drop events for their aircraft or another aircraft.

The data can also be sent to other stakeholders as follows: The processor reformat the data and broadcasts the data for despatch to, for example, but not limited to ground fire fighting personnel, hikers, environmental protection groups, and other aircraft.

The foregoing technology can be best understood by way of the following examples.

Example 1:

By way of example, a suitable exemplary system that reports dump and/or load information comprises a hardware component that includes a load cell or other suitable strain gauge, a payload controller, a sensor data collector and communication manager and messaging, flight tracking and data communication and a onboard satellite communication device that provides messaging, flight tracking and data communication.
Example 2:

By way of example, a suitable exemplary system that reports Fill, Foam, Dump, and/or Load information comprises a hardware component 12 that includes: a load cell 16 or other suitable strain gauge; and sensors to do all or a portion of weights, tank volumes, fill or injector pump flow, and/or time on of fill switches, a payload controller 52, a sensor data collector 54 and communication manager 56, and an onboard satellite communication device 64 that provides voice, messaging, flight tracking and data communication or messaging, flight tracking and data communication.

Example 3:

By way of example, a suitable exemplary system that reports Fill, Foam, Dump, and/or Load information comprises a hardware component 12 that includes: a load cell 16 or other suitable strain gauge; and sensors to do all or a portion of weights, tank volumes, fill or injector pump flow, and/or time on of fill switches, a display unit 50, a payload controller 52, a sensor data collector 54 and communication manager 56, and an onboard satellite communication device 64 that provides voice, messaging, flight tracking and data communication or messaging, flight tracking and data communication.

Example 4:

By way of example, a suitable exemplary system that reports dump and/or load information comprises a hardware component 12 that includes a load cell 16 or other suitable strain gauge, a payload controller 52, a sensor data collector 54 and communication manager 58. It will utilize the sensor data collector and communication manager discrete output or an open source event protocol. For example, the sensor data collector 54 and communication manager 58 (provided as an integrated unit or otherwise) gathers the drop/payload data and then communicate the event to another peripheral radio equipped device, for example, another satcom unit, and from there to a third party drop analysis program. As such, some of the value of the drop event may be lost or cannot be guaranteed to contain all the parameters or the accuracy as it is not staying within the proprietary system as outlined in the present disclosure.

Example 5:

By way of example, a suitable exemplary system is configured to measure and manage fire suppressant load types including water, retardant, and retardants including foam and gel injection systems. The system supports all Bambi Bucket® products and other manufacturer's
belly-tank air delivery systems for all aircraft types. Vehicular mobile (ground deployed) reservoirs are also tracked and reported on. The operational load settings for equipment is configured for live transmission of selected load and related event parameters and extensive onboard memory allows for more detailed flight data analysis to be downloaded post-mission.

Example 6:

By way of example, the system and method were proven experimentally. The tracking system used a load cell attached to the belly hook as well as additional switch inputs to collect the following data:

- bucket or tank volume;
- drop start (release) location; and
- drop end location.

In the air: Using the present system, to determine volume, the software read the load cell when the bucket was empty. When the bucket was full and the pilot pushed the release button the software read the load cell again, before release and after. The software used these values to calculate DROP VOLUME. The software was calibrated for the specific product used; in this case, water.

To acquire the location data, the tracking system used a commercially available GPS. The software recorded the latitude and longitude of the helicopter when the pilot pushed the release button. Because the present system recorded the drop end location as well as the drop start location, we were able to calculate drop length from the data set.

On the ground: Bucket and tank volumes were measured with a flow meter on a filling hose on the ground. A ground team marked the drop start and end locations on the ground which were then recorded with differential GPS. The values were used to calculate drop length.

Results: Drop Location (Bucket Only): The differences between the measured drop start and end locations and those recorded by the tracking system are summarized in Table 1 along with calculated drop lengths.

The drop locations recorded by the tracking system software were offset from the actual locations between 5 - 56m; or an average of 21m. Except for Drop 5, the calculated drop lengths from the tracking system data were within 10m of the measured length.

Table 1. Measured drop location and system recorded drop location variances and calculated drop lengths.
<table>
<thead>
<tr>
<th>Drop No.</th>
<th>Drop Start Variance (m)</th>
<th>Drop End Variance (m)</th>
<th>Measured Drop Length (m)</th>
<th>System Drop Length (m)</th>
<th>Drop Length Variance (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5.9</td>
<td>4.5</td>
<td>33.1</td>
<td>34.2</td>
<td>1.2</td>
</tr>
<tr>
<td>2</td>
<td>11.5</td>
<td>9.7</td>
<td>27.3</td>
<td>27.8</td>
<td>0.5</td>
</tr>
<tr>
<td>3</td>
<td>20.4</td>
<td>11.8</td>
<td>64.4</td>
<td>73.5</td>
<td>9.1</td>
</tr>
<tr>
<td>4</td>
<td>22.8</td>
<td>44.7</td>
<td>85.4</td>
<td>63.5</td>
<td>21.9</td>
</tr>
</tbody>
</table>

Example 7:

By way of example, the system and method were tested on fixed wing aircraft in the field. The aircraft was a Lockheed® P2V-5 tanker with a fixed suppressant tank mounted to the belly of the aircraft fuselage with 6 separated compartments, each with their own release door. In the P2V-7 system, there are no sensors to detect fluid level so amounts of suppressant dropped are provided as the full tank volume regardless of whether suppressant is actually present in the tank when the doors opened. The tank system provides the 6 individual discrete signals used by the tracking system 10 to detect which, if any, tank doors are in the open state. Note that the doors cannot be partially opened. Once the door is opened the entire load for the associated door is jettisoned.

The system installed comprised a payload controller 52, a sensor data collector 54 having extensive onboard memory and communication manager 56 having satellite telemetry 58, tracking 60 and a messaging transceiver 62, and a onboard satellite communication device 64. The sensor data collector 54 was used for gathering the drop door states, determining sequence related events and storing all gathered data. The onboard satellite communication device 64 was used for the transmission of the generated messages for real-time ATIS messages. Data were collected and analyzed. It was shown that accurate drop information could be collected.

Example 8:

A fire attack aircraft prepared for takeoff. The aircraft was equipped with a payload controller 52, a sensor data collector 54, a communication manager 56 and an onboard satellite communication device 64. The tank was filled to 3150 gallons. At that point or at least at take-off, the sensor data collector 54 generated a "FILL" message, including time, location and fill details (volume, type, weight). This is transmitted via communication manager 56 and the
satcom unit 64 to the remote servers (processors) 76 at the base station 70). The message was processed by the remote servers and displayed in the flight following website 80. The aircraft settled at a cruising altitude of 17000 ft.

The aircraft was monitored for the entire flight duration for GPS altitude, GPS speed, cabin pressure, tank pressure, tank float positions (x4), tank volume, radar altimeter, weight on wheels, tank doors, speed brake, flaps, IMU yaw/pitch/roll, IMU three-axis accelerometer, and pitot/static derived airspeed. Upon approach to the forest fire and drop location, the aircraft dropped to 5600 feet above sea level as registered by the GPS altitude. The radar altimeter reported the altitude as 2100 feet above ground.

The fire was located on a ridge above a river valley. The aircraft got closer to the ridge, and as it passed the radar altimeter drops to 170 feet. The crew engaged the drop tank equipment. The sensor data collector 54 and communication manager 56 generated a "DROP START" message with the current GPS location and tank volume level and transmit via the satcom unit 64 to the remote servers 74. Doors 1, 2, 3 and 4 were opened and closed and 2300 gallons of water was dropped. The sensor data collector 54 and communication manager 56 generated a "DROP END" message with the current GPS location, tank volume, radar altimeter reading and which doors were used for the drop and transmitted via the satcom unit 64 to the remote servers 74. The aircraft looped around again and dropped the remaining 750 gallons on the fire. Within minutes of the events occurrence, the ground flight crew and management were apprised of the drop locations and load status via the web application 80.

The aircraft continued down the river valley and landed at the nearest air field. Upon landing, the weight on wheels and GPS speed indicated that the aircraft was on ground, and uploads the latest data logs. The drop tank was refilled to 3250 gallons and the fire attack aircraft immediately resumed the fire attack procedure.

All methods described herein can be performed in any suitable order unless otherwise indicated herein or otherwise clearly contradicted by context. The use of any and all examples, or exemplary language (e.g., "such as") provided herein, is intended merely to better illuminate the example embodiments and does not pose a limitation on the scope of the claimed invention unless otherwise claimed. No language in the specification should be construed as indicating any non-claimed element as essential.
Advantages of the exemplary embodiments described herein may be realized and attained by means of the instrumentalities and combinations particularly pointed out in this written description. It is to be understood that the foregoing general description and the detailed description are exemplary and explanatory only and are not restrictive of the claims below.

While example embodiments have been described in detail, the foregoing description is in all aspects illustrative and not restrictive. It is understood that numerous other modifications and variations can be devised without departing from the scope of the example embodiment.

While example embodiments have been described in connection with what is presently considered to be an example of a possible most practical and/or suitable embodiment, it is to be understood that the descriptions are not to be limited to the disclosed embodiments, but on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the example embodiment. Those skilled in the art will recognize, or be able to ascertain using no more than routine experimentation, many equivalents to the specific example embodiments specifically described herein. Such equivalents are intended to be encompassed in the scope of the claims, if appended hereto or subsequently filed.
What is claimed is:

[Claim 1] A method for tracking a payload drop from an aircraft, the method comprising:
sensing the beginning of the drop;
sensing the end of the drop;
relating the beginning of the drop to a first geographical location to provide a first data point;
relating the end of the drop to a second geographical location to provide a second data point;
determining a vector between the first and second data points; and
reporting the beginning, end and vector of the drop, thereby tracking the payload drop.

[Claim 2] The method of claim 1, further comprising sensing the readiness of a drop.

[Claim 3] The method of claim 1 or 2, wherein sensing is effected by a door position sensor.
[Claim 4] The method of claim 1 or 2, wherein sensing is effected by a load sensor.
[Claim 5] The method of any one of claims 1 to 4, further comprising collecting data points
at a plurality of geographical locations throughout the drop and optionally sensing at the plurality of geographical locations.
[Claim 6] The method of any one of claims 1 to 5, further comprising collecting raw data.
[Claim 7] The method of claim 6, further comprising relaying the data points and raw data
to a base station in real-time.
[Claim 8] The method of claim 7, further comprising analyzing the data after a mission is completed.
[Claim 9] The method of claim 8, further comprising utilizing web-based mapping and data management to analyze the data.
[Claim 10] The method of any one of claims 1 to 9, wherein the aircraft is a helicopter.
[Claim 11] The method of any one of claims 1 to 9, wherein the aircraft is a fixed wing aircraft.
[Claim 12] A payload carrier information system for use in an aircraft, the system comprising
at least one signaler configured to report payload status prior to a drop, at the start of the drop and, at a minimum, at the end of the drop, a payload controller, a signaler data collector, a display unit operably linked to the sensor data collector, and a communication manager comprising satellite telemetry, and tracking.
[Claim 13] The system of claim 12, wherein the at least one signaler is configured to provide at least one of load weight, tank volume, fill or injector pump flow, time on of fill switches, and payload door status.

[Claim 14] The system of claim 12 or 13, wherein the signaler is a door position sensor.

[Claim 15] The system of claim 12 or 13, wherein the signaler is a load cell.

[Claim 16] The system of any one of claims 12 to 15, further comprising an onboard satellite communication device for communicating with a base station.

[Claim 17] The system of claim 16, wherein the onboard satellite communication device includes voice, messaging, flight tracking and data communication or messaging, flight tracking and data communication.

[Claim 18] The system of claim 14, wherein the payload controller is a door control unit.

[Claim 19] The system of claim 15, wherein the payload controller is a bucket control unit.

[Claim 20] The system of claim 18 wherein the aircraft is a fixed wing aircraft.

[Claim 21] The system of claim 18 or 19 wherein the aircraft is a helicopter.

[Claim 22] A payload carrier data collection and analysis system for use with an air tanker, the air tanker having at least one tank with at least one sensor to report payload status at the start of the drop and at the end of the drop and a payload controller, the payload carrier data collection and analysis system comprising an onboard a sensor data collector, an onboard communication manager comprising satellite telemetry, and tracking, an onboard satellite communication device and a base station, the base station comprising a processor configured to analyze the data to provide a drop vector.

[Claim 23] A method for tracking a payload load and drop event from an aircraft, the method comprising:

receiving data on a load being loaded;
optionally, receiving data reporting sensing the readiness of a drop;
receiving data reporting sensing the beginning of the drop;
receiving data reporting sensing the end of the drop;
relating the beginning of the drop to a first geographical location to provide a first data point;
relating the end of the drop to a second geographical location to provide a second data point;
determining a vector between the first and second data points; and
reporting the beginning, end and vector of the drop, thereby tracking the payload drop.
[Claim 24] The method of claim 23, further comprising collecting data points at a plurality of geographical locations throughout the drop and optionally receiving data reporting sensing at the plurality of geographical locations.

[Claim 25] The method of claim 23 or 24, further comprising collecting raw data.

[Claim 26] The method of claim 25, further comprising relaying the data points and raw data to a base station in real-time.

[Claim 27] The method of claim 26, further comprising analyzing the data after a mission is completed.

[Claim 28] The method of claim 27, further comprising utilizing web-based mapping and data management to analyze the data.

[Claim 29] The method of any one of claims 23 to 28, wherein the data on the load includes a type of load, and one or more of a volume and a weight of the load.

[Claim 30] The method of claim 29, wherein the data on the load includes a location and a loading time.

[Claim 31] An operational loads management system for use with an aircraft, the system comprising: an at least one onboard signaler configured to report payload status including load, start of a drop and end of a drop; an onboard payload controller; an onboard signaler data collector; an onboard communication manager including satellite telemetry, and tracking; an onboard internal inertial measurement unit (IMU); and an onboard pitot-static system.

[Claim 32] The operational loads management system of claim 31, further comprising an onboard satellite communication device.

[Claim 33] The system of claim 32, wherein the onboard satellite communication device includes voice, messaging, flight tracking and data communication or messaging, flight tracking and data communication.

[Claim 34] The operational loads management system of claim 32, further comprising a base station, the base station having a processor configured to analyze the communicated data.
FIG. 3
FIG. 4
INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2014/059353

A. CLASSIFICATION OF SUBJECT MATTER
IPC: B64D 1/02 (2006.01), B64D 47/00 (2006.01), H04W 4/12 (2009.01), H04B 7/185 (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimunm documentation searched (classification system followed by classification symbols)
IPC: B64D 1/02 (2006.01), B64D 47/00 (2006.01), H04W4/12 (2009.01), H04B 7/185 (2006.01)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic database(s) consulted during the international search (name of databases) and, where practicable, search terms used
Google: ATIS, air tanker information system, latitude, tracking
IEPODOC: IPC: B64D 1/02 (2006.01), B64D 47/00 (2006.01), H04W 4/12 (2009.01), H04B 7/185 (2006.01)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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