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(54) **FLIGHT OPTIMIZATION SYSTEM AND METHOD FOR AIRLINE OPERATIONS**

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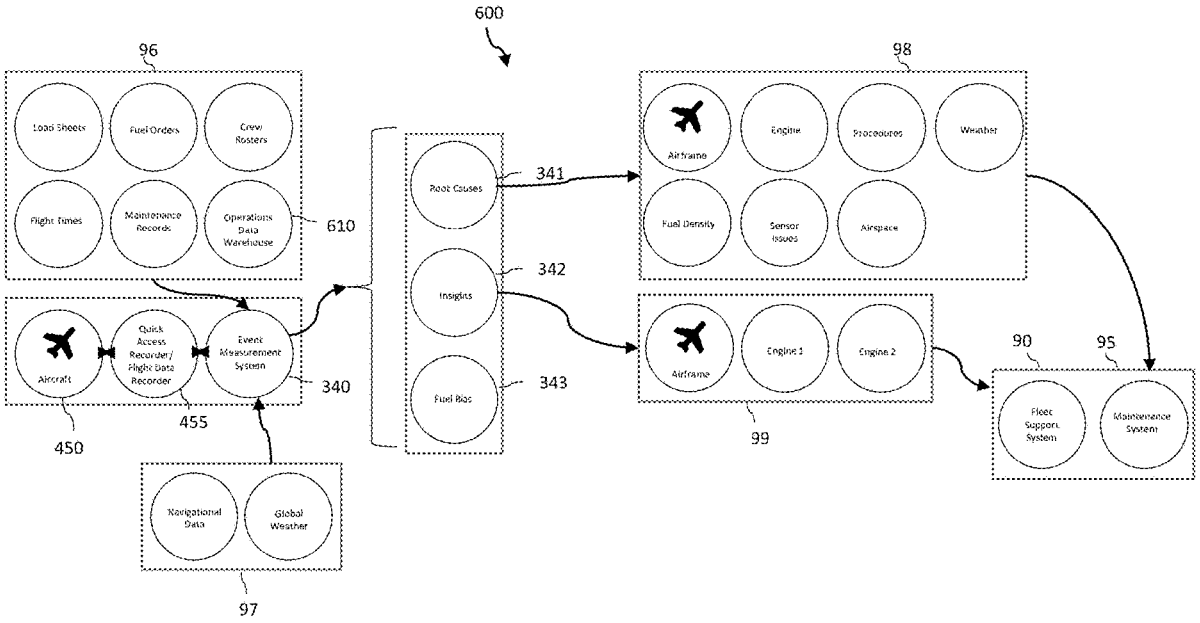
(57) **ABSTRACT**

Provided is a flight optimization system and a method of flight optimization that includes generating flight data via an onboard aircraft system, performing a pre-flight cycle by determining an updated tail assignment plan before departure based on the flight data received in real-time from the onboard aircraft system, performing an in-flight cycle by collating and processing in-flight data and external data via an onboard network server, and transmitting the processed data to an electronic flight bag in real-time and performing flight path optimization via a path optimizer application of the electronic flight bag to be accessed by flight personnel, and performing a post-flight cycle by transmitting post-flight data to an event measurement system along with operational data to be processed and sent to a fleet support system and a maintenance system for generating updated flight plans and maintenance plans which are data-driven.



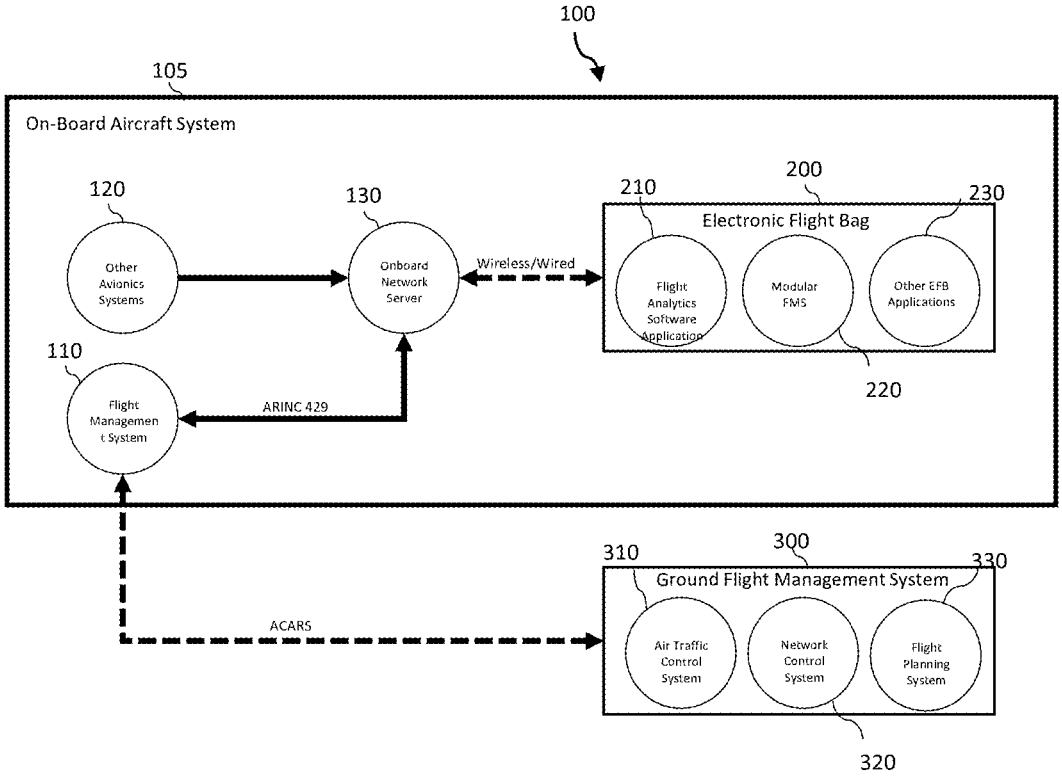

100
105
On-Board Aircraft System
120
Other Avionics Systems
130
Onboard Network Server
Wireless/Wired
200
210
Electronic Flight Bag
230
Flight Analytics Software Application
Modular FMS
Other EFB Applications
220
110
Flight Management System
ARINC 429
ACARS
300
310
Ground Flight Management System
330
Air Traffic Control System
Network Control System
Flight Planning System
320

Fig. 1

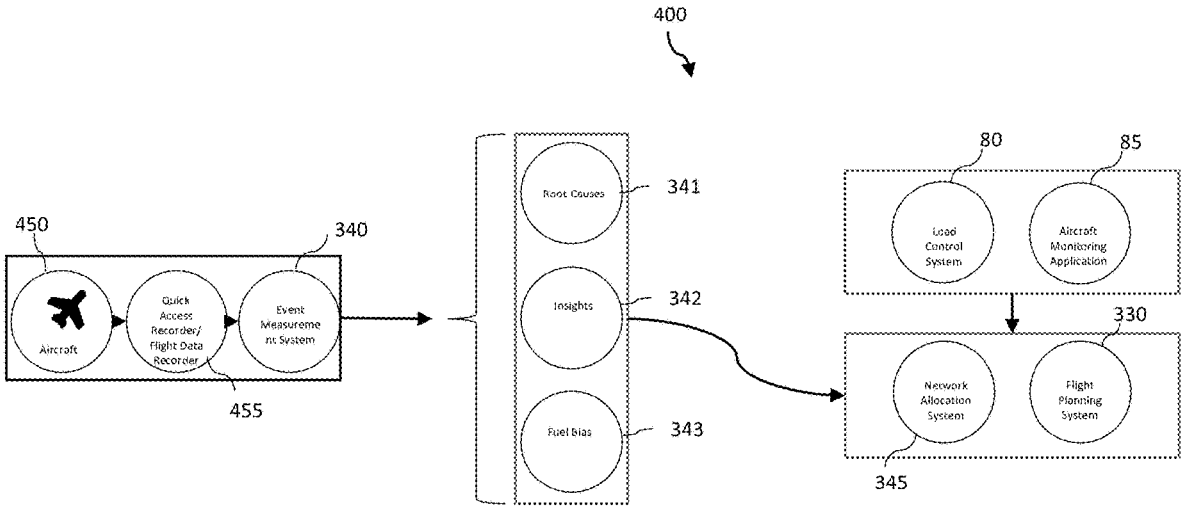

400
450
340
Aircraft
Quick Access Recorder/ Flight Data Recorder
Event Measurement System
455
Root Causes
341
Insights
342
Fuel Bias
343
80
85
Load Control System
Aircraft Monitoring Application
330
Network Allocation System
Flight Planning System
345

Fig. 2

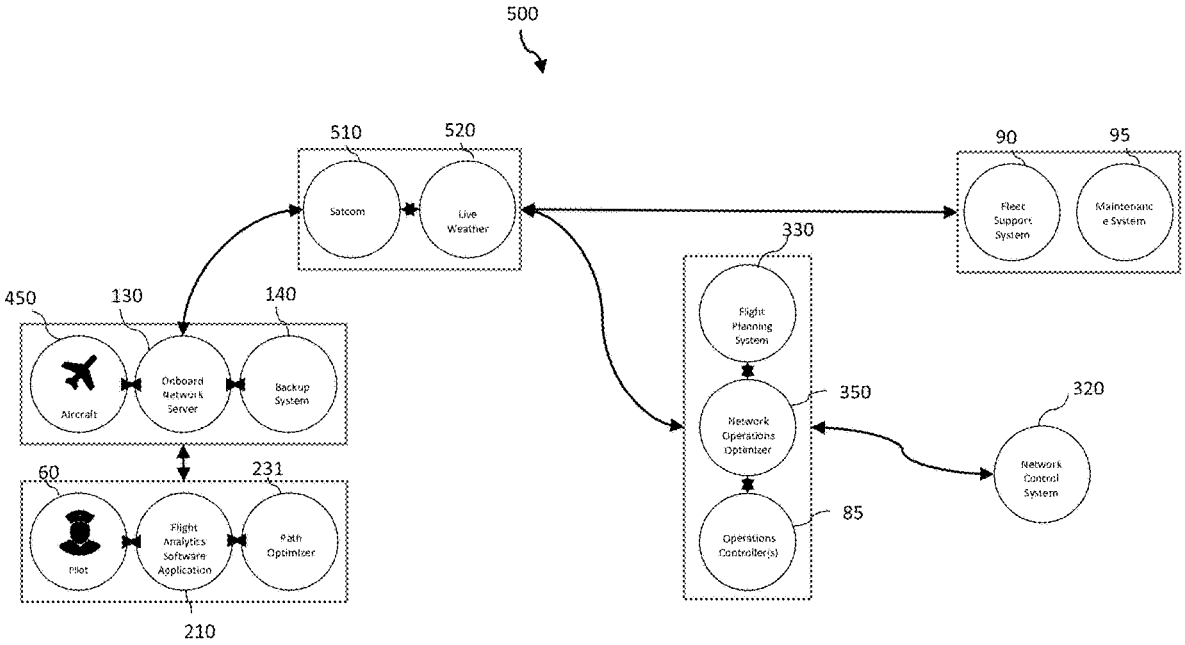

500
510
520
Satcom
Live Weather
90
95
Fleet Support System
Maintenance System
330
Flight Planning System
450
130
140
Aircraft
Onboard Network Server
Backup System
350
320
Network Operations Optimizer
Network Control System
85
Operations Controller(s)
60
231
Pilot
Flight Analytics Software Application
Path Optimizer
210

Fig. 3

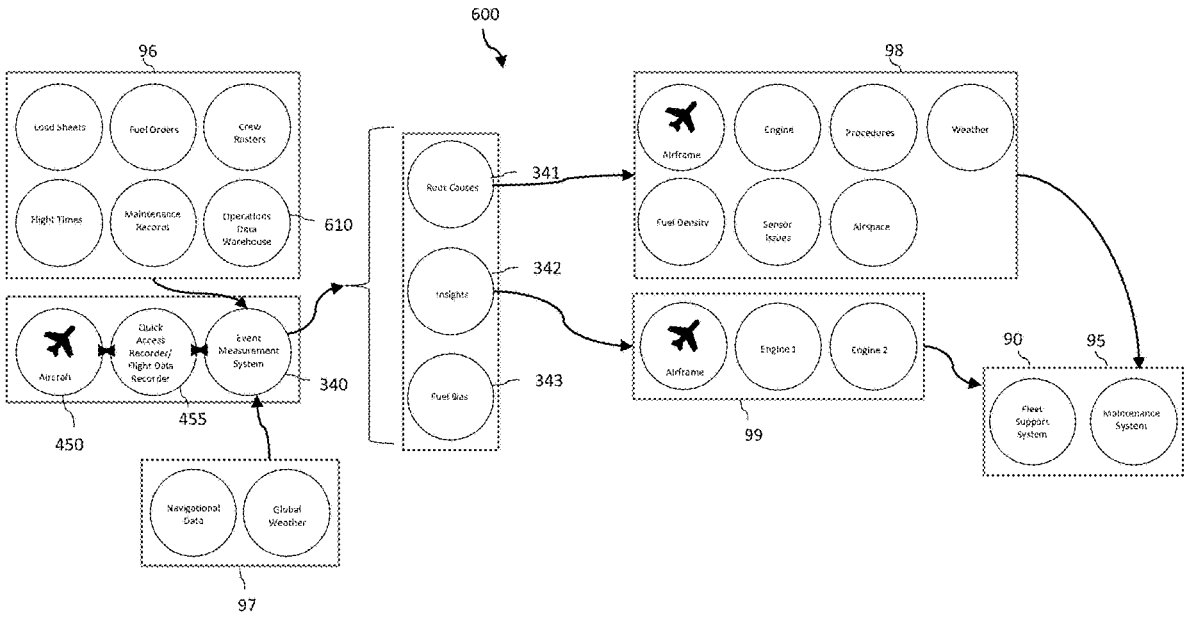

600
96
Load Sheets
Fuel Orders
Crew Rosters
Flight Times
Maintenance Records
Operations Data Warehouse
610
Aircraft
Quick Access Recorder/ Flight Data Recorder
Event Measurement System
340
450
455
Navigational Data
Global Weather
97
Root Causes
341
Insights
342
Fuel Bias
343
98
Airframe
Engine
Procedures
Weather
Fuel Density
Sensor Issues
Airspace
Airframe
Engine 1
Engine 2
99
90
95
Fleet Support System
Maintenance System

Fig. 4

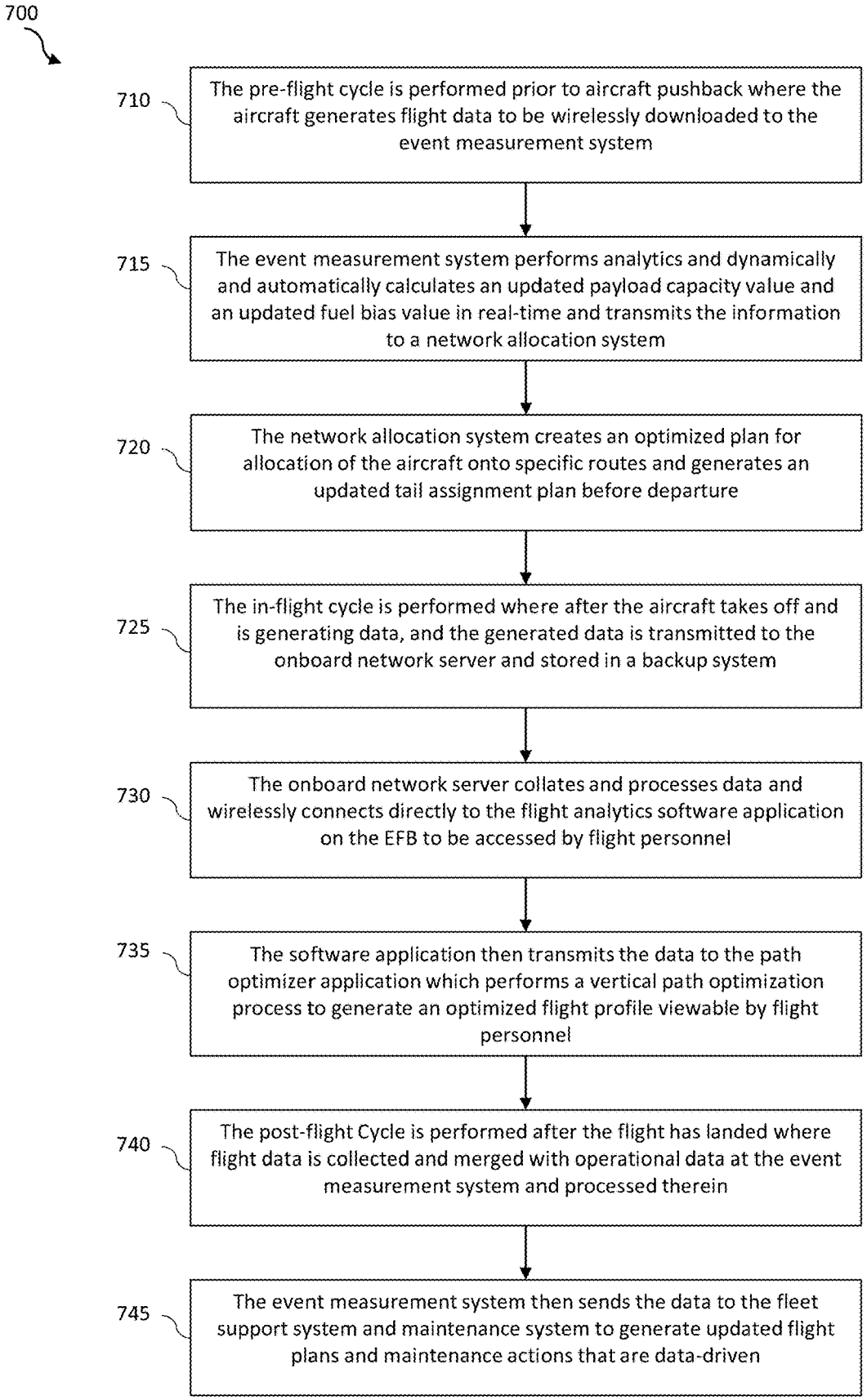

700
710
The pre-flight cycle is performed prior to aircraft pushback where the aircraft generates flight data to be wirelessly downloaded to the event measurement system
715
The event measurement system performs analytics and dynamically and automatically calculates an updated payload capacity value and an updated fuel bias value in real-time and transmits the information to a network allocation system
720
The network allocation system creates an optimized plan for allocation of the aircraft onto specific routes and generates an updated tail assignment plan before departure
725
The in-flight cycle is performed where after the aircraft takes off and is generating data, and the generated data is transmitted to the onboard network server and stored in a backup system
730
The onboard network server collates and processes data and wirelessly connects directly to the flight analytics software application on the EFB to be accessed by flight personnel
735
The software application then transmits the data to the path optimizer application which performs a vertical path optimization process to generate an optimized flight profile viewable by flight personnel
740
The post-flight Cycle is performed after the flight has landed where flight data is collected and merged with operational data at the event measurement system and processed therein
745
The event measurement system then sends the data to the fleet support system and maintenance system to generate updated flight plans and maintenance actions that are data-driven

Fig. 5

FLIGHT OPTIMIZATION SYSTEM AND METHOD FOR AIRLINE OPERATIONS

I. CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims benefit to a U.S. Provisional Application No. 62/870,871, filed Jul. 5, 2019, which is hereby incorporated by reference in its entirety.

II. TECHNICAL FIELD

[0002] The technical field relates generally to flight optimization for airline operations. In particularly, a flight optimization system and methods performed within various phases of a flight of an aircraft including dynamic aircraft allocation, flight planning, flight path optimization and post flight analysis.

III. BACKGROUND

[0003] Currently, airline operations base flight planning and payload limits on modeling as provided by airframers and engine manufacturers. Many conventional systems use these global standards to generate existing flight plans. Therefore, there may be undesired fuel usage, payload restrictions, flight delays and additional costs incurred.

[0004] There is a desire to be able to dynamically adjust airline operations during pre-flight, in-flight and post-flight phases of a flight of an aircraft in order to obviate the above-mentioned issues.

IV. SUMMARY OF THE EMBODIMENTS

[0005] The present invention addresses the above-mentioned issues by providing a flight optimization system capable of dynamically adjusting aircraft scheduling and flight planning at various cycles of airline operations including pre-flight, in-flight and post-flight phases.

[0006] Embodiments of the present invention provide a flight optimization system that includes an onboard aircraft system having a flight management system and an onboard network server, the onboard network server receives flight data from the aircraft, an event measurement system wirelessly downloads the flight data from the onboard network server in real-time, and initiates analytics on the flight data and dynamically and automatically calculates updated payload capacity and fuel bias values in real-time; and a network allocation system receives the updated payload capacity and fuel bias values and data from an external load control system and an aircraft monitoring system, and creates an optimized plan for allocation of the aircraft onto specific routes and generating an updated tail assignment plan before departure to be sent back to an associated airline for manual updates or directly to the aircraft for automatic updates.

[0007] According to another embodiment, the flight optimization system performs the in-flight phase of the flight, where the onboard network server receives in-flight data generated during the flight in real-time and weather data from an external source, collates and processes the in-flight data and the weather data through analytics, and wirelessly connects directly to an electronic flight bag having an analytics software application installed therein to be accessed by flight personnel, and receives the flight data and weather data as processed in real-time.

[0008] According to an embodiment, the flight optimization system further includes a path optimization application downloadable to the electronic flight bag and that receives the processed data from the analytics software application in real-time and performs a vertical path optimization process, via the onboard network server, by changing a vertical control policy in a climb phase of flight and utilizing the in-flight data and weather data processed to generate an optimized flight path including a unified climb, cruise and decent profile.

[0009] According to yet another embodiment, the flight optimization system further initiates a post-flight cycle after landing the aircraft, where the onboard network server (e.g., aircraft quick access recorder) receives post-flight data and wirelessly download the post-flight data to the event measurement system, and the event measurement system also receives operational data via external operational sources of an associated airline and merges the operational data with the post-flight data and analyzes the aircraft and engines of the aircraft and sends associated data to the fleet support system, the maintenance system and other operational systems such as flight planning.

[0010] According to still another embodiment, a method of flight optimization and a computer-readable medium of the above-mentioned flight optimization system are also provided.

[0011] The foregoing has broadly outlined some of the aspects and features of various embodiments, which should be construed to be merely illustrative of various potential applications of the disclosure. Other beneficial results can be obtained by applying the disclosed information in a different manner or by combining various aspects of the disclosed embodiments. Accordingly, other aspects and a more comprehensive understanding may be obtained by referring to the detailed description of the exemplary embodiments taken in conjunction with the accompanying drawings, in addition to the scope defined by the claims.

IV. DESCRIPTION OF THE DRAWINGS

[0012] FIG. **1** is a block diagram of the flight optimization system according to one or more exemplary embodiments of the present invention.

[0013] FIG. **2** is a block diagram illustrating a pre-flight cycle implemented by the flight optimization system of FIG. **1** according to one or more exemplary embodiments of the present invention.

[0014] FIG. **3** is a block diagram illustrating an in-flight cycle implemented by the flight optimization system of FIG. **1** according to one or more exemplary embodiments of the present invention.

[0015] FIG. **4** is a block diagram illustrating a post-flight cycle implemented by the flight optimization system of FIG. **1** according to one or more exemplary embodiments of the present invention.

[0016] FIG. **5** is a flow diagram illustrating a complete life cycle of the flight optimization system including the pre-flight, in-flight and post-flight cycles of FIGS. **2**, **3** and **4** according to one or more exemplary embodiments of the present invention.

[0017] The drawings are only for purposes of illustrating preferred embodiments and are not to be construed as limiting the disclosure. Given the following enabling description of the drawings, the novel aspects of the present disclosure should become evident to a person of ordinary

skill in the art. This detailed description uses numerical and letter designations to refer to features in the drawings. Like or similar designations in the drawings and description have been used to refer to like or similar parts of embodiments of the invention.

V. DETAILED DESCRIPTION OF THE EMBODIMENTS

[0018] As required, detailed embodiments are disclosed herein. It must be understood that the disclosed embodiments are merely exemplary of various and alternative forms. As used herein, the word "exemplary" is used expansively to refer to embodiments that serve as illustrations, specimens, models, or patterns. The figures are not necessarily to scale and some features may be exaggerated or minimized to show details of particular components. In other instances, well-known components, systems, materials, or methods that are known to those having ordinary skill in the art have not been described in detail in order to avoid obscuring the present disclosure. Therefore, specific structural and functional details disclosed herein are not to be interpreted as limiting, but merely as a basis for the claims and as a representative basis for teaching one skilled in the art.

[0019] Embodiments of the present invention provide a flight optimization system that dynamically performs optimization of flight operations systems during pre-flight, in-flight and post-flight cycles of an aircraft system. The flight optimization system is implemented utilizing on-board analytics in electronic flight bags (EFBs) including flight crew individualized flight data, aircraft connectivity hardware and software, on-ground flight analytics and a network allocation unit. The system improves tail performance including fuel consumption, passenger load, flight routes and overall performance of a specific aircraft of an airline fleet. Each aircraft has individual characteristics varying from tail number to tail number (i.e., from the departure location to the destination) so each onboard aircraft system **105** needs to be personalized for the tail. For a given tail, performance can change over time, for example, as engines wear at different rates and seals degrade, or the aircraft accumulates dirt and water in the structure, or patches and repairs and repainting increases weight and drag. So the on-board aircraft system **105** and the flight planning system **330** on the ground need to be not only tail-specific but updated continuously and automatically with new performance parameters and other real-time date to ensure optimum planning and operation of each flight of the aircraft **450**. Therefore, unlike conventional systems, the flight optimization system **100** of the present invention optimizes the overall flight including the tail performance at the aircraft's **450** level.

[0020] As shown in FIG. **1**, the flight optimization system **100** includes an onboard aircraft system **105** comprising a flight management system (FMS) **110** integrated with the Communications Management Unit **110**, other avionics systems **120** including onboard sensors and cockpit displays and an onboard network server **130** being an aircraft interface device (AID).

[0021] The flight management system **110** integrated with the Communications Management Unit **110** is configured to perform inflight management of flight plans using various sensors to determine flight position and weather conditions, for example. The flight management system **110** is also configured to provide an air-to-ground, two-way data link direct to the ground system via the aircraft's VHF radio, satcom or digital telephone system via the Communication Management. Unit.

[0022] As shown, the flight management system **110** and the other avionics systems **120** both communicate with the onboard network server **130** via a two-way avionics data bus such as an aeronautical communications services e.g., an Aeronautical Radio (ARINC®) **429** and/or Ethernet.

[0023] The onboard network server **130** is an aircraft interface device (AID) interfacing between the aircraft systems and the crew's electronic flight bags (EFBs) **200** which are also included in the onboard aircraft system **105**. The onboard network server **130** is configured to transfer data to and from the EFBs **200** via a wireless or wired network. The server **130** provides data recording, wireless connectivity, terminal wireless connectivity, Wi-Fi for crew devices, data loading, EFB data interface and application hosting.

[0024] Each Electronic flight bag (EFB) **200** includes personalized flight analytics software application **210** such as Flightpulse®, a modular flight management system (FMS) and other EFB applications **230** including for example, a path optimizer application **231** (as depicted in FIG. **3**). Other EFB applications include map/charting applications, weather applications, fuel ordering and flight planning applications including aircraft performance and aircraft system manuals. The software application **210** connects pilots directly to personal flight analytics by merging flight data with other operational information. The application **210** also provides analytics related to safety and fuel usage to enable pilots to increase their operational efficiency. The EFB **200** can be accessed by the Pilot or other flight personnel via a mobile device e.g., an iPad® or the like.

[0025] Although only one EFB **200** is shown for illustration purposes, the invention can be implemented within multiple EFBs **200** at the same time.

[0026] Also shown, the flight optimization system **100** is also in communication with a ground flight management system **300** including air traffic control system **310**, network control system **320** and flight planning system **330**. The flight management system **110** receives and transmits data to and from the ground flight management system **300** via an Aircraft Communications Addressing and Reporting System (AGARS) which is a digital data link system for transmission of short messages between an aircraft and ground via Airband radio or satellite. Alternatively, the data can be transmitted via other type of satellite or secure broadband systems.

[0027] The air traffic control system **310** facilitates control of aircraft traffic on the ground and through airspace. The network control system **320** is used to monitor the location and configuration of aircraft throughout the network. It provides operations staff with an overview of what is happening and can provide alerts if there are issues. The flight planning system **330** plans the required fuel for an aircraft to complete its flight. The plan takes into consideration, distance, weather, passenger loads, cargo loads, aircraft defects or limitations and other regulatory limits.

[0028] Additional details regarding the communications between the onboard aircraft system **105** and the ground flight management system **300** will now be discussed with reference to FIGS. **2** through **5** below.

[0029] As shown in FIG. **2**, the first cycle performed by the flight optimization system **100** is the pre-flight cycle **400** of a flight. Although, flight planning is performed well in

advance of the flight, the flight optimization system **100** performs a route optimization as a part of the pre-flight cycle **400** of the flight. According to embodiments of the present invention, the pre-flight cycle **400** occurs prior to aircraft pushback. In some embodiments, pre-flight cycle can range from between 3-5 days before and approximately 5-6 hours before a given flight of the aircraft **450**.

[0030] During pre-flight cycle **400**, an aircraft **450** generates flight data corresponding to data which was available during the off-boarding process when the aircraft **450** returned to the gate after a previous completed flight. The flight data is stored and transmitted through a Quick Access Recorder (QAR) or Flight Data Recorder (FDR) **455** which is also included in the onboard aircraft system **105** (e.g., the onboard network server **130** or the other avionics systems **120**, as depicted in FIG. **1**) of the aircraft **450**. The QAR/FDR **455** is configured to record specific aircraft parameters e.g. aircraft speed, location, altitude, systems pressures and temperatures and other items that are selected by airlines. The QAR/FDR **455** communicates with the ground flight management systems **300** via for example, a stand-alone Wi-fi or cellular system.

[0031] The flight data includes aircraft generated data and engine generated data. The onboard network server **130** including the aircraft interface device (AID) is configured to read the flight data from data buses of the aircraft **450**. The onboard network server **130** is also configured to determine when the aircraft **450** has landed on the ground, at which point it transmits recorded data from the quick access recorder/flight data recorder **455** to the ground flight management system **300** (as depicted in FIG. **1**).

[0032] The ground flight management system **300** further includes an event measurement system (EMS) **340**. The flight data stored in the quick access recorder/flight data recorder **455** is wirelessly downloaded to the event measurement system (EMS) **340** over a wireless communication such as a 4G LTE connection.

[0033] The event measurement system **340** is configured to (i) perform analytics using a set of algorithms to determine root causes **341** of aircraft inefficiencies, (ii) provide insights **342** regarding events that occurred on the aircraft **455** and (iii) calculate fuel bias **343** that an aircraft will burn compared to a default predetermined model provided by associated aircraft manufacturer stored in the event measurement system **340**. According to some embodiments, the root causes **341** can include airframe draft (e.g., incorrect maintenance action, dirty aircraft, incorrect planning system assumptions), engine performance (e.g., fuel density or engine wear). Also, according to some embodiments, the insights **342** include which engine or aircraft has the best performance. The event measurement system **340** analyzes the fuel burn deterioration, actual historical route performance, statistical wind models and variations in aircraft empty weight of the aircraft **450** and then dynamically and automatically calculates an updated passenger or cargo carrying capacity (i.e., a payload capacity value) in real-time.

[0034] The event measurement system **340** further calculates the fuel bias **343** by assigning an updated fuel bias value and displaying the probable root causes **341** of the fuel inefficiencies. The fuel bias information including the updated fuel bias value are then used by the flight planning system **330** and a network allocation system **345** which is also included in the ground flight management system.

[0035] The network allocation system **345** is configured to receive the data from the event measurement system **340** and from external sources such as a load control system **80** and network control system **320** which tracks the aircraft **450**, and from the flight planning system **330**; and create an optimized plan for the allocation of the aircraft **450** onto specific routes that the aircraft **450** will fly. The network allocation system generates the optimized aircraft allocation plan using additional statistical modeling and the payload information received from the EMS **340** to generate passenger and cargo payload caps on payload-limited routes taking into account relative fuel burn deterioration, actual historical route performance, historical engine performance records, maintenance records, aircraft configuration data (e.g., the number of seats on the aircraft), aircraft minimum equipment list, current flight routes, planned passenger load, forecasted weather, historical weather conditions and statistical wind models and variations in aircraft empty weight. The network allocation system **345** proactively generates an updated aircraft tail assignment plan days before departure and recommends passenger loads based on operations and efficiency requirements for aircraft **450**. The optimized plan is then sent from the network allocation system **345** to the appropriate airline personnel for performing manual updates or sent via a messaging system (e.g., adhoc schedule message (ASM) updates) back to the appropriate source systems such as reservations, crew control and crew applications. for automatically updating those systems for the airline. Updates are also sent back to the EFBs **200** of the crew of the appropriate aircraft **450**.

[0036] As shown in FIG. **3**, the second cycle performed by the flight optimization system **100** is the in-flight cycle **500** of a flight. According to embodiments of the present invention, the in-flight cycle **500** occurs after the aircraft **450** has taken off. Longer flights which exceed approximately 19 or more hours require continual monitoring during operation. There is increased pressure to reduce the time in which an aircraft (e.g., the aircraft **450**) sits on the ground and the ability to recover proactively when problems arise can make the different between on-time departures and costly delays. The flight optimization system **100** is able to improve risk mitigations, and when problems arise derive efficient paths to recovery by suggesting action plans that take into consideration the operating and financial impacts associated with each previously detected aircraft performance issue.

[0037] As shown in FIG. **3**, after the aircraft **450** has taken off and is generating data, the generated data is transmitted to the onboard network system **130**. The information is also stored in a backup system **140** which can be a real-time computer network airborne system such as an integrated modulated avionics (IMA) system, for example. The onboard network server **130** is configured to further receive data including live weather data **520**, for example, from a communications satellite (e.g., SATCOM) **510**.

[0038] Upon receiving the generated data, the onboard network server **130** collates and processes the data through airframe and engine models customized to the specific aircraft and engine serial numbers. The onboard network server **130** wirelessly connects directly to the flight analytics software application **210** on the EFB **200** to be accessed by flight personnel (e.g., a Pilot **60**) in order to provide the crew with the generated data directly from the onboard network server **130** and process it in real-time. According to other embodiments, the onboard network server **130** may transmit

the data to the ground flight management system **300** for further analysis and monitoring prior to sending it to the EFB **200**. The present invention provides the benefit of sending the data directly from the onboard network server **130** to the EFB **200** for accessing so that the Pilot **60** can have access to updated flight routes when there is limited connectivity or communication with the ground flight management system **300** is impacted by bad weather conditions or solar weather issues.

[0039] The real-time livestream data received by the software application **210** and the path optimizer application **231** from the onboard network server **130**. The path optimizer application **231** is configured to perform further flight path optimization using path optimization techniques. The path optimization techniques include vertical path optimization by changing the vertical control policy in the climb phase of flight and utilizing additional weather and flight plan information to generate a full unified climb, cruise and decent (UCCD) profile and generate a more optimized flight profile by finding ideal locations to step climb or descend. The optimization process implements a variable speed, variable thrust climb profile based on aircraft performance parameters and integrated with real time wind and temperature data. The optimized flight information is then viewable by the Pilot **60** via the EFB **200**. The real-time availability of this optimized flight information also allows the Pilot **60** to perform self-learning. Further, according to other embodiments, the data from the EFB **200** including the optimized flight information can be aggregated to the event measurement system **340** to provide further insight to the flight personnel at the pre-flight cycle **400** to understand safety issues and fuel burn considerations, for example for upcoming flight.

[0040] There are several advantages of the path optimizer application **231** according to embodiments of the present invention including that the entire flight trajectory can be optimized instead of only a single phase of flight so that every pound of fuel spend climbing is gained back by a more efficient cruise; the weather between waypoints interpolated for time-of-flight is used in the vertical path optimization calculations instead of just weather at entered waypoints; and an optimal flight path is continuously recalculated in real-time while the aircraft **450** travels so as data changes the information is fed back into the aircraft **450**.

[0041] As the data is being processed by the onboard network server **130** and the flight being optimized by the path optimizer application **231** the processed data and optimized flight path data is sent to the Operations controller(s) **85**, the flight planning system **330** and a network operations optimizer **350** of the ground flight management system **300**. Within the ground flight management system **300** the data is then compared to full historic data for the aircraft **450**. The comparison to full historic data of the aircraft **450** enables the system **100** to forecast whether the aircraft **450** will be able to complete the flight without any issues. According to one embodiment, if the system **100** determines that the aircraft **450** will not be able to successfully complete the flight a trigger alert is generated and sent to the network operations optimizer **350** for recovery purposes.

[0042] According to an embodiment of the present invention, the network operations optimizer **350** is configured to receive the real-time data received from the aircraft **450** and processed via the onboard network server **130** and further processes the data via algorithms taking into account aircraft restrictions, passenger connecting flight information, airline flight schedules, and flight crew duty periods, for example. The network operations optimizer **350** further simulates different scenarios revolving around flight cancellations, delays or diversions to thereby generate an action plan which will have a positive impact on revenue, operational costs, on-time performance, passenger itineraries, and passenger satisfaction levels. The action plan is then transmitted to the network control system **320** for further optimized tracking of the aircraft **450** and sent back to the onboard network server **130** of the aircraft **450** for any necessary updates.

[0043] The information from the onboard network server **130** is also sent to the OEM fleet support team **90** and maintenance monitoring **95** so airline personnel (e.g., engineers and maintenance crew) are aware of all flight plan updates and any safety issues onboard the aircraft **450** in real-time.

[0044] As shown in FIG. **4**, the third cycle performed by the flight optimization system **100** is the post-flight cycle **600** of a flight. According to embodiments of the present invention, the post-flight cycle **600** occurs after the aircraft **450** has landed. The onboard-network server **130** (as depicted in FIGS. **1** and **3**) is configured to recognize when the aircraft **450** has landed.

[0045] The post-flight cycle **600** implemented within the aircraft **450** uses the same data stored in the quick access recorder/flight data recorder **455** as used during the pre-flight cycle in addition to other data as discussed below. During the post-flight cycle **600**, the flight data offboarding process for the aircraft **450** is initiated when the aircraft **450** returns to the gate post-flight. The flight data from the aircraft **450** which is stored in the quick access recorder/flight data recorder **455** is wirelessly downloaded to the event measurement system **340**. The data is obtained via the onboard network server **130** (as depicted in FIG. **1**). The event measurement system **340** also receives operational data **96** from key operational sources of an associated airline including aircraft-related data as well as specific engine-related data of the aircraft **450**. The operational data **96** is ingested, decoded and stored with the flight data collected from the aircraft **450**. Some of the operational data includes for example, load sheets, fuel orders, flight times, maintenance records, crew rosters, and corporate data. The event measurement system **340** also receives navigational data and global weather data **97** from external navigational sources and weather sources. Similar to in the pre-flight cycle **400**, in the post-flight cycle **600** the event measurement system **340** is configured to (i) perform analytics using a set of algorithms to determine root causes **341** of aircraft inefficiencies, (ii) provide insights **342** regarding events that occurred on the aircraft **455** and (iii) calculate fuel bias **343**. The root causes **341** includes data **98** associated with the airframe, engine, procedures weather, fuel density, any sensor issues and airspace information. Further, the insights **342** includes data **97** associated with the airframe and specific engine-related data for engine 1 and engine 2 for example. The data **98** and **99** is sent to the fleet support system **90** and the maintenance system **95** for further analysis and updating of associated aircraft-related concerns (e.g., flight plans, maintenance plans).

[0046] Referring now to FIG. **5**, is a flow diagram illustrating a method **700** of a complete life cycle of the flight optimization system **100** will now be discussed in reference

to the pre-flight, in-flight and post-flight cycles **400**, **500** and **600** of FIGS. **2**, **3** and **4** according to one or more exemplary embodiments of the present invention.

[0047] The method **700** begins at operation **710**, wherein the pre-flight cycle **400** is performed prior to aircraft push-back where flight data from previous flights are stored and transmitted through a QAR/FDR in the onboard aircraft system, and then wirelessly downloaded to the event measurement system (EMS) **340** over a wireless communication. At operation **715**, the event measurement system performs analytics and dynamically and automatically calculates an updated payload capacity value and an updated fuel bias value in real-time and transmits the information to a network allocation system. At operation **720**, the network allocation system creates an optimized plan for allocation of the aircraft onto specific routes and generates an updated tail assignment plan before departure to be sent back to airline or aircraft for manual or automatic system updates, respectively.

[0048] Next, at operation **725**, the in-flight cycle **500** is performed where after the aircraft takes off and is generating data the generated data is transmitted to the onboard network server and stored in the backup system. At operation **730**, the onboard network server collates and processes data and wirelessly connected directly to the flight analytics software application on the EFB to be accessed by flight personnel. At operation **735**, the same data is used by the path optimizer application which performs a vertical path optimization process to generate an optimized flight profile viewable by the flight personnel. Embodiments of the in-flight cycle allows for corrective action in real-time as well as decision support and recovery efforts.

[0049] Lastly, at operation **740**, the post-flight cycle **600** is performed after the flight has landed where flight data is collected and merged with operational data from key operational sources of the airline in the event measurement system and processed therein. The event measurement system **340** then sends the data to the fleet support system and the maintenance system generate updated flight plans and maintenance actions which are data-driven, to thereby ensure efficient operations of the aircraft and its engines (at operation **745**).

[0050] An additional advantage of the flight optimization system **100** according to embodiments of the present invention include the airline's ability to use the data collected and analyzed to determine the aircraft and/or engines to be installed on the aircraft which would result in a more efficient flight.

[0051] Those skilled in the relevant art(s) will appreciate that various adaptations and modifications of the embodiments described above can be configured without departing from the scope and spirit of the disclosure. For example, while exemplary embodiments have described in the context of presence in and occupancy of a room, embodiments of the present disclosure can be deployed in other settings like a car windshield in order to detect rain or snow, or at an outdoor light fixture to determine changes in the weather or nearby traffic patterns, or for in a store to determine patron traffic and store occupancy. Therefore, it is to be understood that, within the scope of the appended claims, the teachings featured herein may be practiced other than as specifically described herein.

What is claimed is:

1. A flight optimization system for an aircraft comprising:

an onboard aircraft system comprising a flight management system and an onboard network server, the onboard network server being configured to obtain flight data from the aircraft;

an event measurement system and configured to wirelessly download the flight data from the onboard network server in real-time, and initiate a pre-flight cycle of a flight of the aircraft by performing analytics on the flight data and dynamically and automatically calculating updated payload capacity and fuel bias values in real-time; and

a network allocation system configured to receive the updated payload capacity and fuel bias values and data from an external load control system and an aircraft monitoring system, and create an optimized plan for allocation of the aircraft onto specific routes and generating an updated tail assignment plan before departure to be sent back to an associated airline for manual updates or directly to the aircraft for automatic updates.

2. The flight optimization system of claim **1**, wherein the event measurement system is further configured to:

perform the analytics using a set of algorithms to determine root causes of aircraft inefficiencies; and

determine insights regarding events that occurred on the aircraft.

3. The flight optimization system of claim **2**, wherein the event measurement system is further configured to analyze fuel burn deterioration, actual historical route performance, statistical wind models and variations in aircraft empty weight.

4. The flight optimization system of claim **1**, wherein the network allocation system generates the optimized plan using statistical modeling and the updated payload capacity and fuel bias values to generate payload caps on payload-limited routes.

5. The flight optimization system of claim **4**, further performing an in-flight cycle of the flight, wherein:

the onboard network server is configured to:

receive in-flight data generated during the flight in real-time and weather data from an external source;

collate and process the in-flight data and the weather data through analytics; and

wirelessly connect directly to an electronic flight bag having an analytics software application installed therein to be accessed by flight personnel, and transmit the in-flight data and weather data as processed in real-time.

6. The flight optimization system of claim **5**, further comprising:

a path optimization application downloadable to the electronic flight bag and configured to receive the processed data from the onboard network server in real-time and perform a vertical path optimization process by changing a vertical control policy in a climb phase of flight and utilizing the in-flight data and weather data processed to generate an optimized flight path including a unified climb, cruise and decent profile.

7. The flight optimization system of claim **6**, wherein the optimized flight path is transmitted to a ground flight management system for further analysis.

8. The flight optimization system of claim **7**, wherein if the ground flight management system determines that the flight will be unsuccessful based on the optimized flight path, a trigger is sent to a network operations optimizer for determining a recovery process, wherein the network operations optimizer is configured to simulate different scenarios to determine an action plan for recovery.

9. The flight optimization system of claim **5**, wherein the in-flight data and the weather data processed by the onboard

network system is transmitted to a fleet support system and a maintenance system in real-time for scheduling of updated flight plans and maintenance actions.

10. The flight optimization system of claim **9**, wherein a post-flight cycle is initiated after landing the aircraft, wherein the onboard network server is further configured to receive post-flight data and wirelessly download the post-flight data to the event measurement system; and

wherein the event measurement system is further configured to receive operational data via external operations of an associated airline and merge the operational data with the post-flight data and analyze the aircraft and engines of the aircraft and send associated data to the fleet support system and the maintenance system.

11. The flight optimization system of claim **10**, wherein the associated data sent to the fleet support includes at least one of airframe, engine, procedures, weather, fuel density, any sensor issues, and airspace information, and the associated data sent to the maintenance system includes at least one of airframe and specific engine-related data.

12. A method of flight optimization via a flight optimization system, the method comprising:

generating flight data via an onboard aircraft system;

performing a pre-flight cycle by determining an updated tail assignment plan before departure based on the flight data received in real-time from the onboard aircraft system;

performing an in-flight cycle by collating and processing in-flight data and external data via an onboard network server, and transmitting the processed data to an electronic flight bag in real-time and performing flight path optimization via a path optimizer application of the electronic flight bag to be accessed by flight personnel; and

performing a post-flight cycle by transmitting post-flight data to an event measurement system along with operational data to be processed and sent to a fleet support system and a maintenance system for generating updated flight plans and maintenance plans which are data-driven.

13. The method of claim **12**, wherein performing of the pre-flight cycle of the flight, comprises:

generating and storing flight data in an onboard aircraft system of an aircraft;

wirelessly downloaded the flight data to an event measurement system over a wireless communication;

performing, via the event measurement system, analytics on the flight data and dynamically and automatically calculates updated payload capacity and fuel bias values in real-time;

transmitting the updated payload capacity and fuel bias values to a network allocation system; and

creating, via the network allocation system, an optimized plan for allocation of the aircraft onto specific routes and generating an updated tail assignment plan before departure to be sent to an associated airline for manual updates or directly to the aircraft for automatic system updates, respectively.

14. The method of claim **13**, wherein performing the in-flight cycle further comprises:

transmitting in-flight data to the onboard network server in real-time;

collating and processing, via the onboard network server the in-flight data and wirelessly connecting directly to a flight analytics software application on the Electronic flight bag to be accessed by flight personnel; and

transmitting, via the onboard network server, the in-flight data to a path optimizer application to perform a vertical path optimization process to generate an optimized flight profile viewable by the flight personnel.

15. The method of claim **14**, wherein performing the post-flight cycle further comprises:

collecting and merging post-flight data with operational data from operational sources of the airline in the event measurement system and processed therein; and

transmitting, processed data via the event measurement system to a fleet support system and a maintenance system for generating updated flight plans and maintenance actions which are data-driven.

16. A computer-readable medium for performing a method of flight optimization via a flight optimization system, via a computer, the method comprising:

the method comprising:

generating flight data via an onboard aircraft system;

performing a pre-flight cycle by determining an updated tail assignment plan before departure based on the flight data received in real-time from the onboard aircraft system;

performing an in-flight cycle by collating and processing flight data and external data via an onboard network server, and transmitting the processed data to an electronic flight bag in real-time and performing flight path optimization via a path optimizer application of the electronic flight bag to be accessed by flight personnel; and

performing a post-flight cycle by transmitting flight data to an event measurement system along with operational data to be processed and sent to a fleet support system and a maintenance system for generating updated flight plans and maintenance plans which are data-driven.

17. The computer-readable medium of claim **16**, wherein performing of the pre-flight cycle of the flight, comprises:

generating and storing flight data in an onboard aircraft system of an aircraft;

wirelessly downloaded the flight data to an event measurement system over a wireless communication;

performing, via the event measurement system, analytics on the flight data and dynamically and automatically calculates updated payload capacity and fuel bias values in real-time;

transmitting the updated payload capacity and fuel bias values to a network allocation system; and

creating, via the network allocation system, an optimized plan for allocation of the aircraft onto specific routes and generating an updated tail assignment plan before departure to be sent back to an associated airline for manual updates or directly to the aircraft for automatic system updates.

18. The computer-readable medium of claim **17**, wherein performing the in-flight cycle further comprises:

transmitting in-flight data to the onboard network server in real-time;

collating and processing, via the onboard network server the in-flight data and wirelessly connecting directly to a flight analytics software application on the electronic flight bag to be accessed by flight personnel; and

transmitting, via the onboard network server, the in-flight data to a path optimizer application to perform a vertical path optimization process to generate an optimized flight profile viewable by the flight personnel.

19. The computer-readable medium of claim **18**, wherein performing the post-flight cycle further comprises:

collecting and merging post-flight data with operational data from operational sources of the airline in the event measurement system and processed therein; and

transmitting, processed data via the event measurement system to a fleet support system and a maintenance system for generating updated flight plans and maintenance actions which are data-driven.

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