AeroTech Research (U.S.A.), Inc.

Summary of AeroTech's Aircraft Simulation Environment Toolset (ASET)

AeroTech Research (U.S.A.), Inc.
11836 Fishing Point Drive, Suite 200
Newport News, Virginia 23606

March 2009

Summary of AeroTech's Aircraft Simulation Environment Toolset (ASET)

1. Introduction

Over the past several years of research and development, AeroTech Research has built and refined an Aircraft Simulation Environment Toolset (ASET) that today can support a variety of current and future project needs. The information presented within this paper will outline at a high level the purpose and content of ASET, specific key modules within its design, and the various display capabilities that have been developed for it.

2. ASET Description

ASET is a multi-purpose software platform designed around the evaluation and simulation of the response of an aircraft to turbulence and weather. Programmed in the JAVA programming language, the architecture basis of the software is modular in design to compartmentalize the various application specific or generic processes applicable to the simulation of the aircraft. As part of the Turbulence Auto-PIREP System (TAPS℠), Enhanced Turbulence (E-Turb) Radar, and other research development efforts, AeroTech has developed this unique suite of simulation tools. These tools can model multiple aircraft and their interaction with large-domain weather in any region of airspace. The aircraft are individual simulations that respond to local turbulence conditions. Currently, eight commercial aircraft types can be simulated with plans to incorporate models for business and regional jets. Weather is incorporated into the simulation as gridded data sets derived from NexRAD products or from weather models. The aircraft respond to the turbulence as they pass through the regions and make TAPS reports as needed. The simulation can model the effects of weather on large regions of airspace and air traffic. The suite includes tools for the development and evaluation of cockpit display concepts by presenting TAPS-derived and Enhanced Turbulence Radar information for any aircraft in the simulation, and evaluation of ground station applications for viewing and filtering TAPS reports made on a large scale (as would be presented to airline dispatchers and ATC controllers). The integration of weather and aircraft response to turbulence makes this multi-aircraft simulation unique.

At the core of the simulation are AeroTech's developed methods to simulate the response of different aircraft types to turbulence based on aircraft data. AeroTech has developed on extensive collection of aircraft simulation data for 8 different aircraft types (B737-300, B737-800, B747-400, B757-200, B767-300, B777-200, A320-200, and MD-88) over a range of weights, airspeeds, and altitudes. When this database is coupled with AeroTech's ASET capabilities, aircraft load response information for a given input wind field can be generated. This provides a compact and easy to use hazard/upset assessment capability without the need to use a complex, certified simulator, which can be costly and difficult to access. The feasibility of the tool has been validated and proven with actual flight data.

Figure 1 shows the system architecture for ASET and a high level view of the data flow between components. From the simulation core, various products and display are available to the end user through various configuration and control methods. These displays can consist of Ground Station Displays for dispatchers or air traffic management, as well as Cockpit Displays for various hardware platforms. Additional data/event reporting programs and interfaces are available or can conveniently tie into the ASET interfaces.

Figure 2 illustrates the simulation core of ASET where the fundamental AeroTech algorithms reside. From the simulation core outputs, various application displays can access the necessary module/component for each of the subsystems within ASET. The core components include the generation of turbulence, the response of the aircraft to the turbulence, TAPS reports, Enhanced Turbulence Radar images, and other performance metrics.

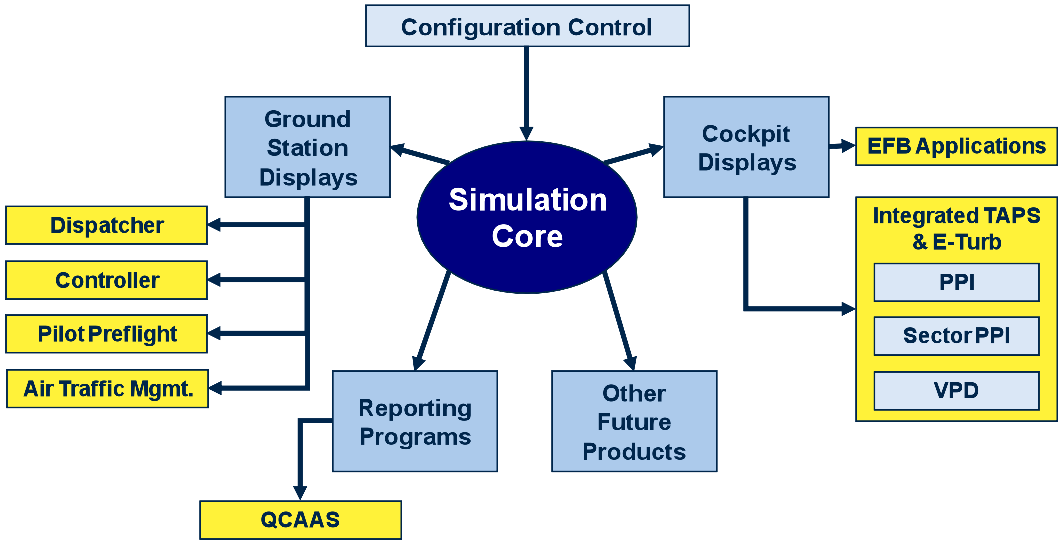

Figure 1: ASET Simulation Architecture

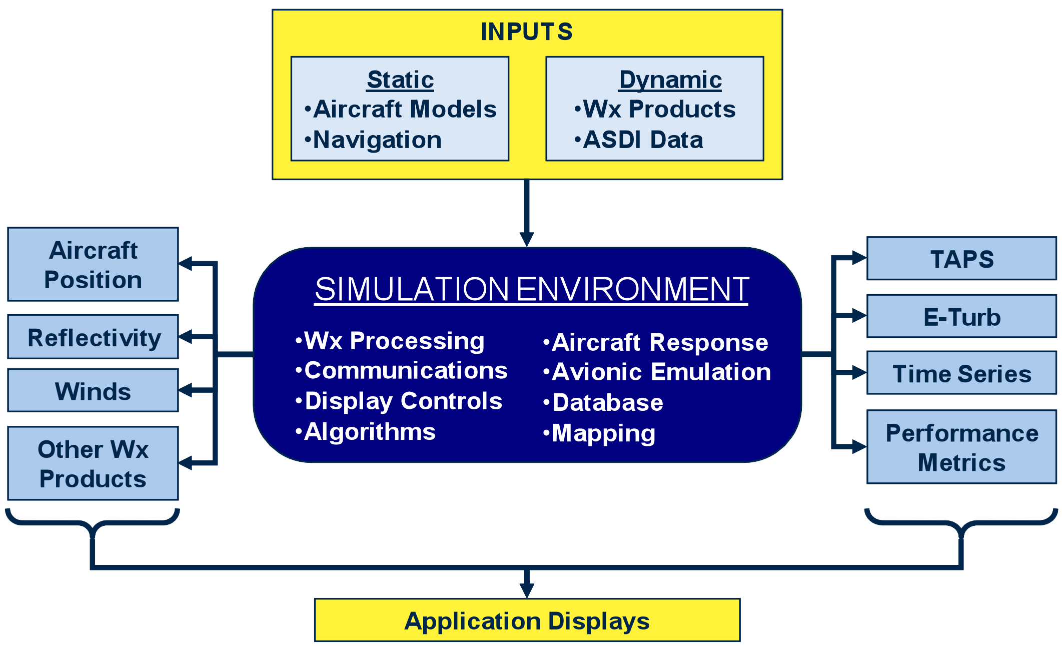

Figure 2: ASET Simulation Core

3. ASET Display Summaries

The following describes in general the various displays that are part of ASET. Each of the display types can be executed for multiple aircraft and displayed simultaneously on appropriate hardware.

3.1 Integrated Cockpit Decision Aid Display

AeroTech has developed an Integrated Turbulence Hazard Decision Aid for the Cockpit that will provide integrated, graphical turbulence hazard information, scaled to each specific aircraft, and presented in the cockpit electronically using a Class III Electronic Flight Bag (EFB) or MFD concept display. The Integrated Cockpit Decision Aid module enables the display to emulate a primary flight display, a MFD, or a Class III EFB. The Integrated Turbulence Hazard Decision Aid cockpit display integrates information from two advanced turbulence technologies developed by AeroTech Research, the Turbulence Auto PIREP System (TAPS^{SM}) and the Enhanced Turbulence (E-Turb) Radar, with conventional weather radar reflectivity data.

The technical challenge is to present the flight crews with a meaningful and useful display depicting the location and severity of turbulence hazards to their aircraft. The information on which to base this display may come from disparate sources – each one satisfying the defined requirements of a turbulence advisory system. There is also a significant technological challenge in fusing the turbulence information and bringing the display formats together. The display must present consistent, understandable information to the pilot no matter what the source (i.e. a moderate turbulence severity report received from one source must mean the same severity as a moderate report from another source).

Figure 3 is an example screenshot of the Integrated Cockpit Display. Further information on the Integrated Cockpit Display, including detailed descriptions of the functions and features of the display, is available on request.

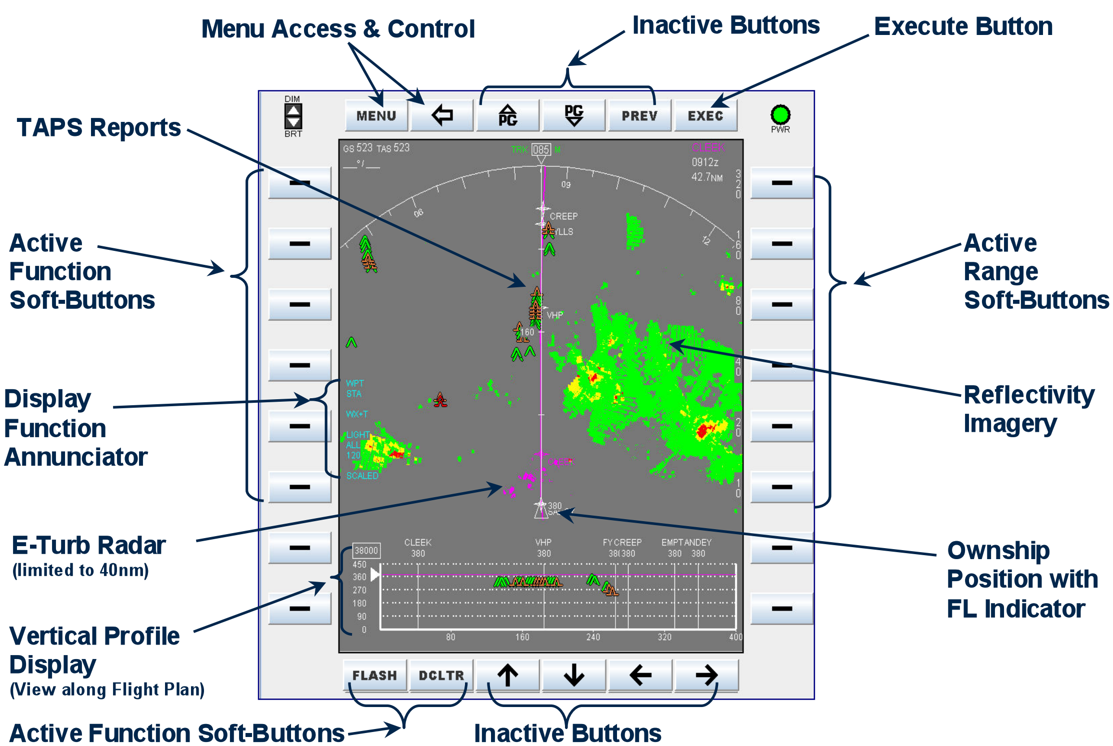

Figure 3: AeroTech's Integrated Cockpit Display

3.2 TAPS℠ Electronic Flight Bag Display

AeroTech has developed a Class II EFB application for the display of TAPS reports in the cockpit. Figure 4 is an example screenshot of the TAPS Class II EFB display. The display emulates Type B EFB software and can incorporate maps, navigation aid information, TAPS reports, NEXRAD reflectivity, flight plans, and various filtering functions. The map type display can also emulate Type C software through the incorporation of an ownship position on the map and flight path. This variation of the display would not be suitable for an actual Class II device at this time due to current software restrictions.

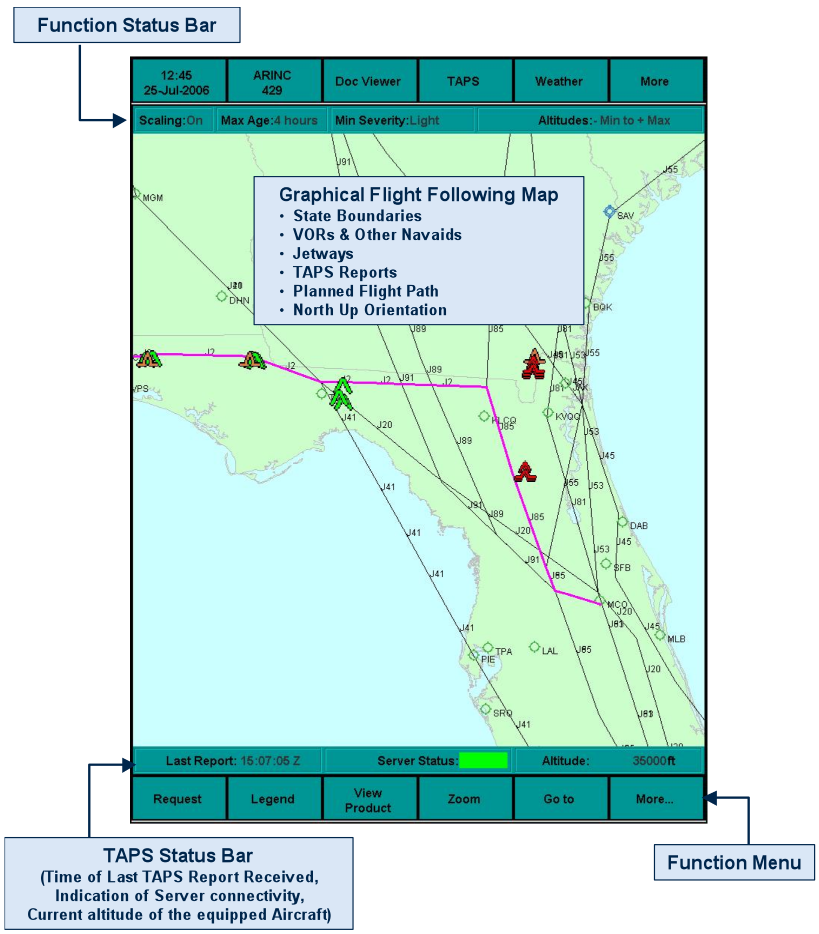

Figure 4: TAPS EFB Application Screen

3.3 JAVA Aircraft Situational Display (JASD)

The Java Aircraft Situational Display (JASD) is the AeroTech Research version of a flight-following tool. In addition to standard flight-following functionality and graphical display information such as aircraft, weather, and navigational aids, JASD has the ability to display TAPS reports and to filter those reports. Functionality associated with AeroTech's Quantitative Condition Alerting and Analysis Support System (QCAAS℠) is also being incorporated into JASD. QCAAS is a maintenance support system which makes real-time reports to dispatch and maintenance when various maintenance events occur in flight. Since JASD displays historical data, the clock used by JASD can be set to start at any arbitrary time appropriate to the data to be displayed.

JASD gets its flight data from files of ASDI data. Flights can be filtered by airline, departure point, and destination. The track history for each flight can be displayed. Currently, flight plans cannot be displayed.

When a flight is selected, a data block is displayed containing information about that flight. The content of the data block can be specified by the user.

For QCAAS, there is a flight-event display area to the right of the map display. When a QCAAS event occurs, information significant for that event is displayed in the flight-event area. Figure 5 presents a screenshot of a basic JASD interface.

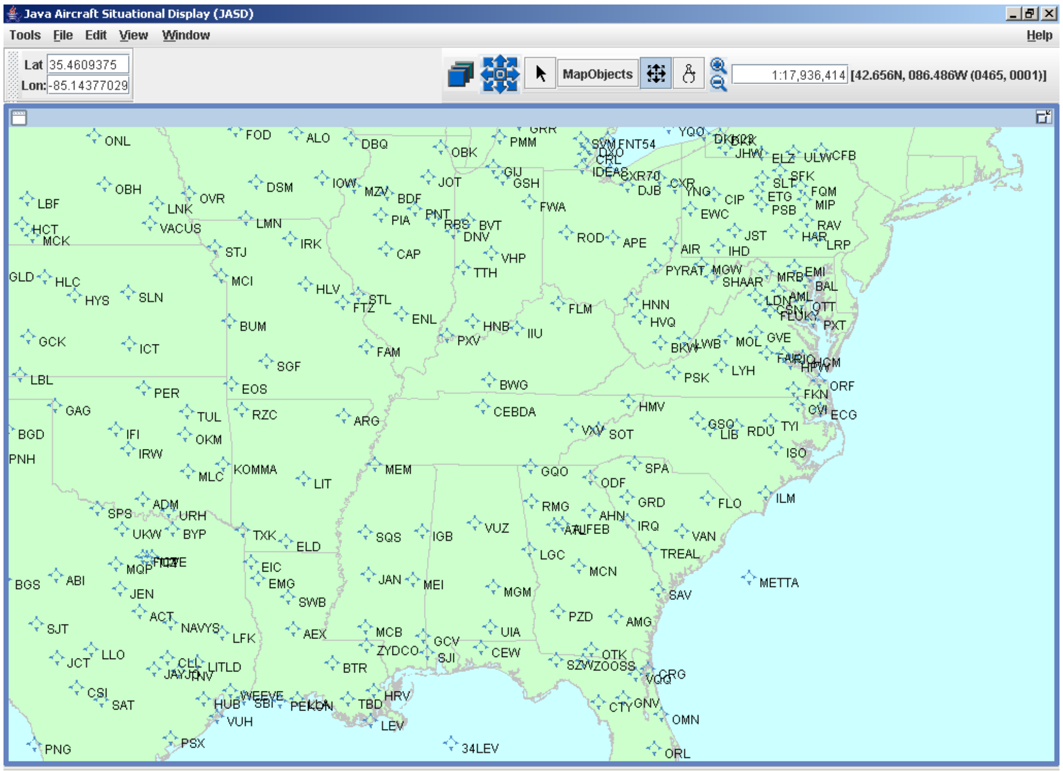

Figure 5: Example JASD Screenshot

3.4 Flight Simulator X (FSX)

Developed and sold by Microsoft Games, a division of Microsoft^{TM}, Flight Simulator X (Figure 6) is the latest platform developed in the line of flight simulator utilities that are commercial off the shelf software (COTS) and are for the general public. In terms of aircraft, it provides a wide variety from an ultralight to a Boeing 747-400, with the capability to add on any number of new aircraft. A dynamic scenery database lets you fly anywhere in the world and land at any of the accurate 24,000 airports within it databases. The FSX Software Development Kit (SDK) allows for an easy development environment for add-ons for the product, including an interface to connect other software programs to the FSX interfaces and outputs from the aircraft environment. This connection utility is what AeroTech takes advantage of to simulate the cockpit of many large transport category aircraft for the purposes of ownship navigation within ASET. The range of output parameters allows for an almost limitless simulation of the aircraft for AeroTech's needs in terms of simulating the cockpit environment for the purposes of evaluation and demonstration.

Figure 6: Microsoft Simulator X Screenshots

During AeroTech's simulations, a pilot subject can fly his aircraft in FSX and the control and positional outputs are incorporated into ASET as an aircraft within the simulation environment. The aircraft will interact with the weather wthin the simulation based on where the subject pilot flies the aircraft. The pilot receives information on his EFB display (whether it is acting as an Integrated Turbulence Hazard Cockpit Display, a TAPS Class II display, or some other variation) relative to his actions on FSX, and his location and the corresponding weather in the ASET scenario.

4. Integration with Training Flight Simulators

The ASET is capable of being and has been integrated with a full motion flight simulator (FFS). ASET and the Integrated Turbulence Hazard Cockpit Display has been integrated with an A320 FFS. The outputs from the A320 FFS were fed into ASET and drove the actions of one aircraft within the ASET scenario/simulation. An Integrated Turbulence Hazard Cockpit Display was put into the cockpit in an EFB and the display was generated by the ASET based on the location and orientation of the FFS aircraft in the simulation. The subject pilots could fly the FFS (using stick or autopilot) and use the Integrated Cockpit Display for turbulence situational awareness and avoidance within the scenarios.

An additional EFB was incorporated into the FFS cockpit (Figure 8), but the technical and system capabilities exist to incorporate any of the ASET cockpit displays into the actual embedded displays (primary flight display, MFD, EFBs) in a FFS. This would be integrated through the FSS host computer/control station.

Figure 8: Display Hardware Arrangement within the Cockpit