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COVER SHEET
Access 5 Project Deliverable

Deliverable Number: FT007

Title: Notional Airspace Operations Demonstration Plan

Filename: FT007_Notional Airspace Operations Plan_v1_FINAL

Abstract: The airspace operations demonstration (AOD) is intended to show that the Access 5 Step 1 functional requirements can be met. The demonstration will occur in two phases. The initial on-range phase will be carried out in restricted airspace to demonstrate the cooperative collision avoidance (CCA) functional requirements and to provide risk-reduction for the AOD by allowing the test team to rehearse some elements of the demonstration mission. The CCA system to be used in these flights is based on Automatic Dependent Surveillance-Broadcast (ADS-B) which is a commercially-available system by which airplanes constantly broadcast their current position and altitude to other aircraft and ground resources over a dedicated radio datalink. The final phase will occur in the national airspace (NAS) and will be the formal demonstration of the remainder of the proposed functional requirements.

The general objectives of the AOD are as follows:

- Demonstrate that the UAS can aviate in the NAS
- Demonstrate that the UAS can navigate in the NAS
- Demonstrate that the UAS can communicate with the NAS
- Demonstrate that the UAS can perform selected collision avoidance functions in the NAS
- Demonstrate that the UAS can evaluate and avoid weather conflicts in the NAS
- Demonstrate that the UAS can provide adequate command and control in the NAS

In addition to the stated objectives, there are a number of goals for the flight demonstration. The demo can be accomplished successfully without achieving these goals, but these goals are to be used as a guideline for preparing for the mission. The goals are:

- Mission duration of at least 24 hours
- Loiter over heavy traffic to evaluate the data block issue identified during the Access 5 Airspace Operations Simulations
- Document the contingency management process and lessons learned
- Document the coordination process for Ground Control Stations (GCS) handoff
- Document lessons learned regarding the process of flying in the NAS

Preliminary planning for a notional mission to achieve the objectives and goals has been prepared. The planning is intended to serve as a guide for detailed planning of the AOD.

Status: **SEIT-Approved**

Limitations on use: This document represents thoughts and ideas of the Flight IPT work package team. It has not been reviewed or approved as an Access 5 project position on this subject. In addition to SEIT review and comment, the information also needs substantiation through simulation/flight demonstrations. This notional AOD plan is just that – a notional plan. The dollar amounts provided are rough order of magnitude (ROM) numbers using FY 06 dollars based on NASA's billing rate of $150 an hour. This AOD and the assumptions and conclusions herein are for budgetary and planning purposes only.

NASA ACCESS 5

Notional Airspace Operations Demonstration Plan

Revision 1

19 February, 2006

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NICHOLAS A. TRONGALE
Access 5 Flight IPT Lead

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

ABSTRACT

The airspace operations demonstration (AOD) is intended to show that the Access 5 Step 1 functional requirements can be met. If flown, the demonstration would occur in two phases. The initial on-range phase would be carried out in restricted airspace to demonstrate the cooperative collision avoidance (CCA) functional requirements and to provide risk-reduction for the AOD by allowing the test team to rehearse some elements of the demonstration mission. The CCA system to be used in these flights is based on Automatic Dependent Surveillance-Broadcast (ADS-B) which is a commercially-available system by which airplanes constantly broadcast their current position and altitude to other aircraft and ground resources over a dedicated radio datalink. The final phase would occur in the national airspace (NAS) and would be the formal demonstration of the remainder of the proposed functional requirements.

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TABLE OF CONTENTS

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

CHARTS

FIGURES

APPENDICES

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INTRODUCTION

A. Executive Summary

The Access 5 Flight Integrated Product Team (IPT) was responsible for conducting flight demonstrations to exhibit the in-flight performance of critical technologies chosen in support of the Technology IPT and to duplicate in the flight arena the specified operations identified in each Access 5 step. General flight requirements were identified by the Technology work packages and Policy IPT and vetted with the Flight IPT. The Flight IPT developed flight objectives from these requirements then developed a flight test plan designed to achieve those objectives. All assets and support for flight activities were procured and coordinated by the Flight IPT with the exception of some test articles specifically identified or developed by Technology work packages. The Flight IPT was directly responsible for acquiring flight approval and overall system integration and test conduct. Flight test activities were documented by the Flight IPT in the form of reports and data delivered to the interested parties. These responsibilities resulted in the completion of a Conflict Collision Avoidance (CCA) Technology Demonstration in FY05 and the initial preparation of an Airspace Operations Demonstration (AOD) that was to be conducted in FY06.

The objective of the CCA Technology Demonstration was to collect data to be used by the CCA work package to validate that work package's collision avoidance simulation. Test conditions accomplished were limited to two participating aircraft (a surrogate UAV and one piloted intruder). Collision scenarios demonstrated covered a wide range of geometries including overtaking, head-on, climbing and diving runs. Data was collected onboard each of the aircraft participating in the demonstration flights, as well as in the ground control station of the surrogate UAV. Fifty-four test conditions were accomplished during the six demonstration flights the covered 27 flight hours. The Flight IPT developed a collision avoidance display and modeling tool designed to assist in planning and execution of the demonstration flights. It used the flight data generated during the demonstration to validate the generic UAV model included in the modeling tool.

The AOD planning resulted in the identification of 72 separate flight requirements that could potentially be demonstrated. A detailed plan was established to demonstrate 66 of the flight requirements over the course of roughly six missions that would be conducted both within special use airspace and within the NAS. Neither a detailed plan nor flight approval was acquired prior to termination of the program. This plan is provided by Access 5 for the use of potential sponsors of this program or for use by government agencies that would desire to conduct an airspace operations demonstration.

B. Limitations of this Notional Plan

It must be understood that this notional airspace operations plan is just that – a notional plan. It assumes that the Altair aircraft will be flown in the proposed configuration for the set number of hours. The dollar amounts provided are rough order of magnitude (ROM) numbers

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good for FY 06. They are based on NASA's billing of $150 per hour which gives a very accurate time in space cost picture to execute this plan as written. If this plan were to be flown, the sponsoring agency would have to submit a statement of work (SOW) to each of the participating organizations who would in turn need to submit a binding proposal to support the SOW. The purpose of this notional AOD is to show what can be accomplished in FY 06 dollars, using the Altair aircraft with Automatic Dependent Surveillance – Broadcast (ADS-B) installed and flying a projected 15 flight hours for CCA testing and performance gathering and a 30 hour AOD in the NAS.

Figure 1.0-2 ALTAIR™ Over California Coast.

C. Background

The AOD plan was developed under the following assumptions of specific organizations fulfilling specific roles and responsibilities. This plan was developed under NASA program management by the Flight IPT. The ALTAIR™ (see Figure 1.0-1) UAS was chosen as the demonstration testbed based on its operating envelope, system architecture and payload capabilities. GA-ASI was selected to perform the needed UAS modification and conduct the flight activities based on their ownership of the testbed and extensive history of UAS experience. Lockheed Martin Aeronautical Systems of Fort Worth Texas was selected to aid in cooperative collision avoidance (CCA) test article integration and test support based on their development of the CCA system and previous support of the CCA flight demonstration. NASA's Dryden Flight Research Center was chosen as the responsible test organization based on their previous safety/flight approval and test plan development on the CCA flight demonstration. NASA's G-III Gulfstream was selected as the intruder aircraft for the CCA demonstration elements based on its previous support of the CCA flight demonstration and all vehicle modifications already being in place to support the CCA portions of the demonstration.

2.0 AOD PLAN/SCOPE

This plan responds to Access 5 Leadership request for the Flight IPT to produce a notional airspace operations plan with the ALTAIR™ aircraft as the test platform.

2.1 GA-ASI DEMONSTRATION SYSTEM AND PLAN/SCOPE

2.1.1 Demonstration System

2.1.1.1 Aircraft System

GA-ASI proposed to use the Predator B derivative, ALTAIR™ to perform the AOD. ALTAIR™ is a company-owned aircraft system, operated under a joint use agreement with NASA. ALTAIR™ endurance is 32 hours at high altitude (above 50,000'). This performance is in excess of that required for the AOD. ALTAIR™ characteristics and flight data are documented in ALTAIR™ Experimenter's Handbook 10-15-01, on file with NASA Dryden and can be obtained from GA-ASI upon request.

2.1.1.2 Ground Control Station (GCS).

The aircraft is controlled by a GA-ASI GCS and is flown by an experienced pilot. Payloads are programmed, monitored and controlled by an experienced payload control technician. The GCS includes the ground data terminals required for both line-of-sight and satellite "over the horizon" ALTAIR™ control. The GCS also includes all the equipment required to plan the AOD missions, and if necessary, re-program ALTAIR™ while airborne to change the operation if required. The GCS also includes all communications equipment required for safe operation of the aircraft in controlled airspace.

2.1.1.3 Operational Base and Aircraft Control

GA-ASI planed to conduct the AOD from one of its flight operations facilities at Gray Butte or El Mirage, California. Therefore, any deployment of the aircraft and GCS would not be

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required. Ku-Band satellite equipment and services would be provided by a subcontractor with experience working with unmanned aircraft. Bushtex, Inc. under contract to GA-ASI, has successfully accomplished this task for GA-ASI in the past. Line-of-sight ALTAIR™ control is provided by GA-ASI using ALTAIR™'s GA-ASI proprietary C-Band data link system.

2.1.1.4 Mission Payloads and Flight Requirements

The Mission Payloads integrated into ALTAIR™ and the flight requirements are as defined by Access 5. ADS-B payload installation onboard ALTAIR™ is shown in Figures 2.1-1.

ADS-B: ADS-B is an air traffic surveillance technology. The system concept is that all, or most, aircraft in an area automatically and continually (i.e. roughly once per second) broadcast several digital data packets which together contain the aircraft's 24 bit address [unique airframe identification], flight identification [call sign], GPS derived latitude and longitude, barometric [or Mode C] altitude plus 3 dimensional velocity, i.e., rate of climb/descent, direction and speed over a dedicated data link.

The broadcast ADS-B packets are received by aircraft equipped with an ADS-B data receiver. The derived data provides a real time cockpit display of traffic information; similar to the ground air traffic management systems except that the traffic is shown in relation to own aircraft's intended track.

2.1.2 Proposed Mission Plan

2.1.2.1 Integration/Test Flights

A series of eight integration/test flights not to exceed 25 hours would be conducted from GA-ASI's base of operations in the High Dessert. These flights will be conducted by GA-ASI and are independent of the 30 operational hours described in the AOD plan below. The purpose of the integration/test flights is to ensure readiness of sensor systems and to demonstrate the CCA functional requirements. Visual Meteorological Conditions (VMC) is required for all flights.

2.1.2.2 AOD Flight (~30 hours)

The AOD Notional mission was designed to demonstrate a vision of routine UAS access to the NAS by combining elements of typical UAS missions into one maximum endurance flight. Figure 2.1.2.2-1 addresses the AOD route of flight and altitudes.

Leg	Route of Flight	Altitude Climb/Descend	Cruise Altitude
1	**Enter NAS**		FL0 to 430
	Grey Butte Launch	FL0 to 100	
	Transit to R2515	FL100	
	Climb in R2515	FL100 to 430	
2	**NAS Transit A to B**		FL430
	R2515 to Prescott Area	FL430	
	G-III Files Similar Plan		
3	**Loiter in NAS**		FL430
	Prescott Area	FL430	
	Arrive & Depart at Predefined Times		
	G-III Remains in Vicinity		
4	**NAS Transit A to B to C**		FL430 to 450+
	Prescott, New Mexico to Montana		
	AVCS Handoff to Ft. Huachuca & Back		
	Non-Standard Flight Plan (Lg. Heading Change)		
	Altitude Changes	FL430 to 450+	
5	**Wx Reroute**		FL450+
	Wyoming		
	Operator Requests Real-Time Reroute		
6	**NAS Transit to Real-Time Station**		FL450+
	In-Flight ID of Loiter Point in Western Montana		
	Arrive at Predefine Time Depart at Non-Defined Time		
7	**NAS Transit from Real-Time Point**		FL450+
	Montana to Oregon		
8	**Loiter in NAS**		FL450+
	SW Oregon		
	Arrive & Depart at Non-Predefined Times		
9	**NAS Transit**		FL450+
10	**Loiter Over Traffic Route**		FL450+
	Yosemite Area		
11	**Transit to Range**		FL450+
12	**Exit NAS**		FL450+ to 0
	Enter R2515	FL450+	
	Descend in R2515	FL450+ to 100	
	Transit to Grey Butte & Land	FL100 to 0	

Figure 2.1.2.2-1 Notional Airspace Operations Demo Route of Flight and Altitudes

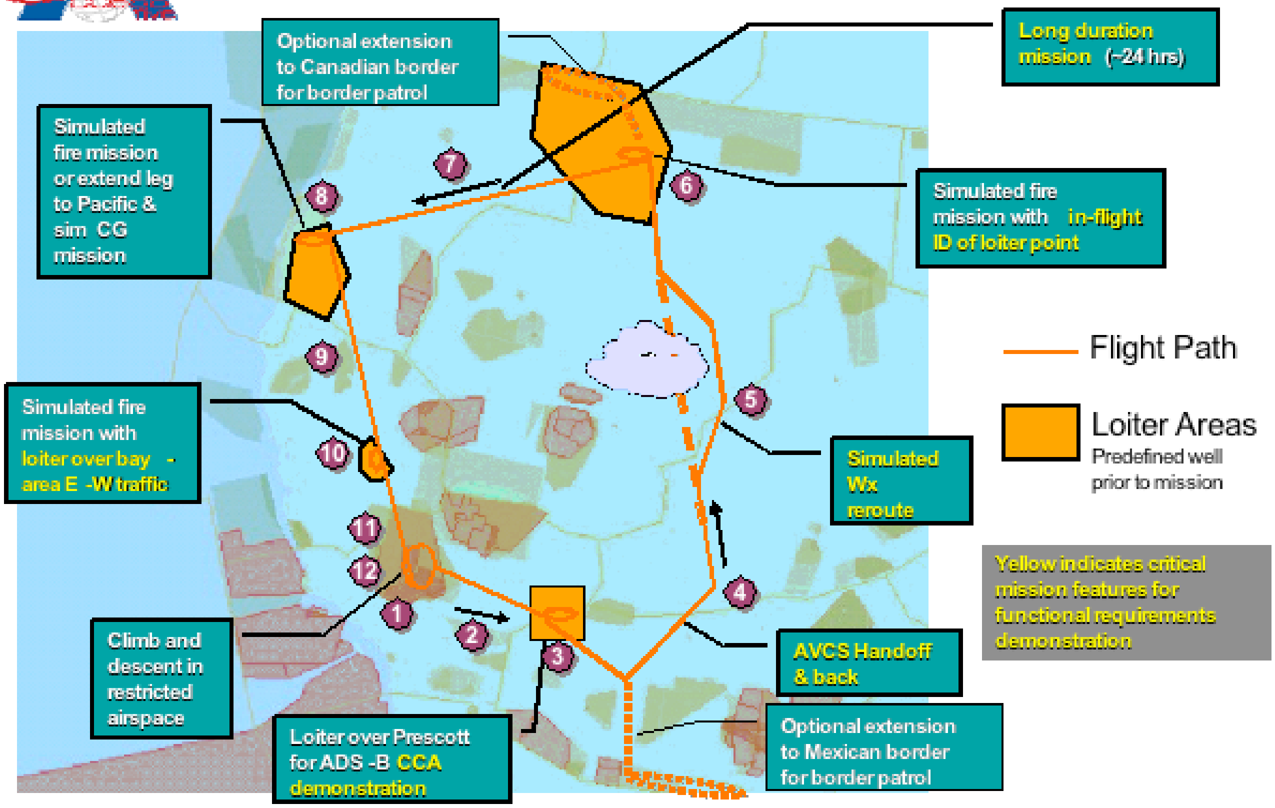

Figure 2.1.2.2-2 Aerial View of AOD Operations Route of Flight

2.2 DEMONSTRATION FLIGHT OPERATIONS

GA-ASI would coordinate Ku coverage for all flights. The demonstration will be conducted using Ku-Band SATCOM and C-Band Line of Sight data links and a chase plane, if required by COA. The sponsor will be required to obtain a COA.

2.3 MEDIA AND PUBLIC RELATIONS COORDINATION

Media releases would be jointly coordinated through the sponsor and participating companies. No releases are permitted without concurrence from all entities. GA-ASI would accommodate, within reason, requests by the sponsor for site demonstrations and media events.

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2.4 POST-DEMONSTRATION LESSONS LEARNED MEETING

The sponsor would arrange and host a meeting, as required, to discuss lessons learned from the demonstration, providing feedback to the sponsor and receiving feedback to facilitate future planning and operations. This meeting may be conducted in person or by conference call and will consist of presentations from all three parties.

2.5 THE COMMON TOOL

The primary purpose of the common tool for the AOD is to communicate with the ALTAIR™ ground station and display ADS-B information to the operator. Specific features include reception of aircraft state information, decision logic for collision avoidance and a display/interface for the collision avoidance systems. Another possible application of the common tool could be to act as a virtual intruder to allow evaluation and testing of the display without having to add the cost of flying an intruder during any in-flight integration testing. The common tool provides the flexibility and mobility to insert display applications or provide simulations of many different platforms into multiple test environments.

3.0 SCHEDULE

It would take approximately eight months from contract award/funds transfer to complete the AOD.

Task Number*	Task	Time Line	Total Days
1	Receive Statement of Work	D- 49	0
2	Receive RFP	D- 35	0
3	Submit Proposal	D- 21	0
4	**Contract Award / Funds Transfer**	**D+ 00**	**49**
5	Complete Engineering and SIL Work-3 months	D+ 90	139
6	Complete Integration of Payload- 1 month	D+ 120	169
7	Completion Ground Testing- 2 wks	D+ 127	176
8	AFSRB for flights-1 day	D+ 127	176
9	Completion flight testing -2 wks	D+ 141	190
10	Completion CCA flights on NASA range- 3 wks	D+ 162	211
11	AFSRB for AOD-1 day	D+162	211
	Complete AOD Mission- 1 wk	**D+ 169**	218
13	System de-integration/pack-up equipment	D+ 178	225
14	Complete Final Report	D+ 220	267

* Task Numbers do not necessarily correspond to the WBS numbering system

Figure 3.0-1 Notional AOD Schedule

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

4.0 DELIVERABLES

4.1 GA-ASI will integrate the ALTAIR™ UAS with ADS-B, and provide the GCS, associated ground support equipment (GSE) and spares required to execute the SOW from GA-ASI facilitates for the period "on or about" of six months after contract award until the completion of the demonstration. For the CCA portion of this plan GA-ASI will provide:

I. Integration and tests of the following payloads:
   a. ADS-B -- GFE

   ADS-B to be integrated with pilot-in-the-loop only –Auto-ADS-B not part of this effort.

II. Engineering Support for Simulation Phase to include:
   a. Project Oversight and Coordination
   b. System and analysis engineering support to refine present aircraft models and provide technical coordination with Access 5 simulation teams for debugging and implementation.
   c. System and analysis engineering support to create AVCS model and provide technical coordination for Access 5 simulation teams for debugging and implementation.

III. Installation Design and SIL Checkout
   a. Project Oversight and Coordination.
   b. H/W & S/W engineering for incorporating protocol interface translators between sensor suite and Gen. P/Load Port channel, ROA & AVCS.
   c. Mechanical design of sensor equipment location, installation hardware and antenna mountings.
   d. Electrical & Physical cable harness design.
   e. Manufacturing harness build.
   f. Write Test Plan
   g. Assemble and test in GA--ASI Rancho Bernardo System Integration Lab (SIL) facility: 2 week period.

IV. Aircraft/AVCS Ground Checkout and Flight/Test Readiness Review
   a. Project Oversight and Coordination.
   b. Aircraft/AVCS Ground Checkout conducted at GA-ASI El Mirage Flight Test Center EMFTC over two weeks.
   c. Provide two Mechanics and two Avionics Technicians for NTE 10 days.
   d. Prepare support and attend FRR NTE 50 hrs. Includes aircraft & payload flight test planning.

V. Configuration Management

   Per GA-ASI company procedure.

VI. System Familiarization and Training Support NTE 300 hours.

VII. Flight Mission
   a. Project Oversight and Coordination.
   b. NTE 10 flight days for 35 flight hours

c. Provide two Mechanics and two Avionics Technicians support for 5 weeks.
d. Provide two pilot/operator crews for 10 flight days.

VIII. Post Flight Analysis Support

a. Project Oversight and Coordination.
b. Equipment removal and ROA normalization.

For the AOD NAS portion of this demonstration GA-ASI will provide:

B. Total Flight Hours: NTE 30 hrs or max endurance.
C. Flights will be flown at completion of CCA phase as stand alone option.
D. Flights will be conducted from Gray Butte or El Mirage if situation requires.
E. Altitude and flight speed will be determined by GA-ASI.
F. Flight Mission shall be flown over a 5 day period.
G. Leased GA-ASI equipment will include GCS, GDT, and ALTAIR aircraft including GSE and fuel.
H. Ku support will be provided under a separate contract.
I. 30 hours of chase plane time is required for flights below 18,000 feet.

4.2 LMCO will supply and support the Common Tool for the AOD. The purpose of the Common Tool is to communicate with the ALTAIR™ ground station and display ADS-B information to the operator. The common tool will communicate externally via UDP over Ethernet using multiple ports. The Common Tool will also act as a virtual intruder to allow evaluation and testing of the display without having to add the cost of flying an intruder along with the Altair during any in-flight integration testing.

4.3 MTSI and Aerovironment will produce the test report and final report.

4.4 Pb Solutions will produce an AOD Plan brief and brief FAA Headquarters and Regional Facilities responsible for the airspace that the ALTAIR™ will fly in.

5.0 GA-ASI PAST PERFORMANCE

General Atomics Aeronautical Systems Inc. (GA-ASI) was formed in 1992 to design, produce, operate, and support unmanned aerial vehicles (UAVs). Figures 5.0-1 through 5.0-3 summarize the family of UAV systems we have developed over the past 15 years.

It has invested heavily in developing advanced technology UAVs that are now in service with the U.S. Government including the U.S. Air Force, U.S. Army, U.S. Navy, NASA and other Government agencies. It has also supplied UAVs to foreign governments.

5.1 SUMMARY OF PROGRAM EXPERIENCE

5.1.1 Unmanned Aircraft— GA-ASI has designed and built over 150 aircraft over the last 15 years. Many of these aircraft were designed and built on company IR&D funds. All aircraft designs except the Prowler variant are in use by their customers today. Predator and Predator B currently comprise over 90% of its production. Predator started as an ACTD and transitioned to production in 1996 under the US Air Force.

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In 2000 to 2001, GA-ASI developed Predator B with internal funding (Figures 5.0-2 and 5.0-3). The U.S. Air Force purchased its company-developed Predator B aircraft system in 2001 and has since ordered 20 production versions. GA-ASI jointly developed ALTUS and Predator B with NASA; these two UAVs were developed for NASA's Environmental Research Aircraft

Sensor Technology (ERAST) program. In 2003, the company developed the I-GNAT ER (extended range) for the U.S. Army (Army I-GNAT).

GA-ASI has invested heavily in production facilities and tooling to meet increasing demand for our products on priority Government programs, and will leverage on this increased capability to supply future orders.

5.1.2 Ground Systems—GA-ASI has developed or modified existing Ground Control Systems (GCS) for each of its UAV customers. Using a common architecture and modular design we have progressively reduced the size, weight, and dimensions of our GCS and associated ground systems to make them more portable and transportable tailored to the needs of our customers. In addition to GCS systems, we have designed, developed, produced, and fielded mobile and portable GCSs (MGCS and PGCS), Ground Data Terminals (GDT), portable GDTs (PGDT), and Remote Video Terminals (RVTs) that are lightweight and portable. GA-ASI tailored these ground systems to customer specifications and desires, and continues to make our ground systems simpler, more reliable and more mobile to reduce logistic footprint.

5.1.3 Ground Support Equipment (GSE)—As technology has advanced and requirements for mobility and reduced logistic footprint have grown, GA-ASI progressively reduced the need for unique GSE. For example, engines on our aircraft are started on internal power. Its aircraft do not require external power, air, etc., to start and maintainability design places access to aircraft components where they are accessible by personnel standing on the ground. GA-ASI continues to ruggedize its GSE and eliminate hardware that requires GSE.

6.0 NASA/DFRC PAST PERFORMANCE

The Dryden Flight Research Center (DFRC) has been responsible for the research and testing of atmospheric air vehicles for NASA. The over five decades of flight test activity include many X-series aircraft, space shuttle landing tests and numerous UAS. The recent Access 5 CCA testing was led by DFRC. The test planning, flight safety and flight approval for CCA tech demo were all structured to directly apply to gaining flight approval for the AOD. DFRC's G-III Gulfstream was modified to fully support testing of the CCA system. Modifications to the G-III included installation of the CCA system and all required instrumentation. No additional modifications are required for the G-III to support the AOD.

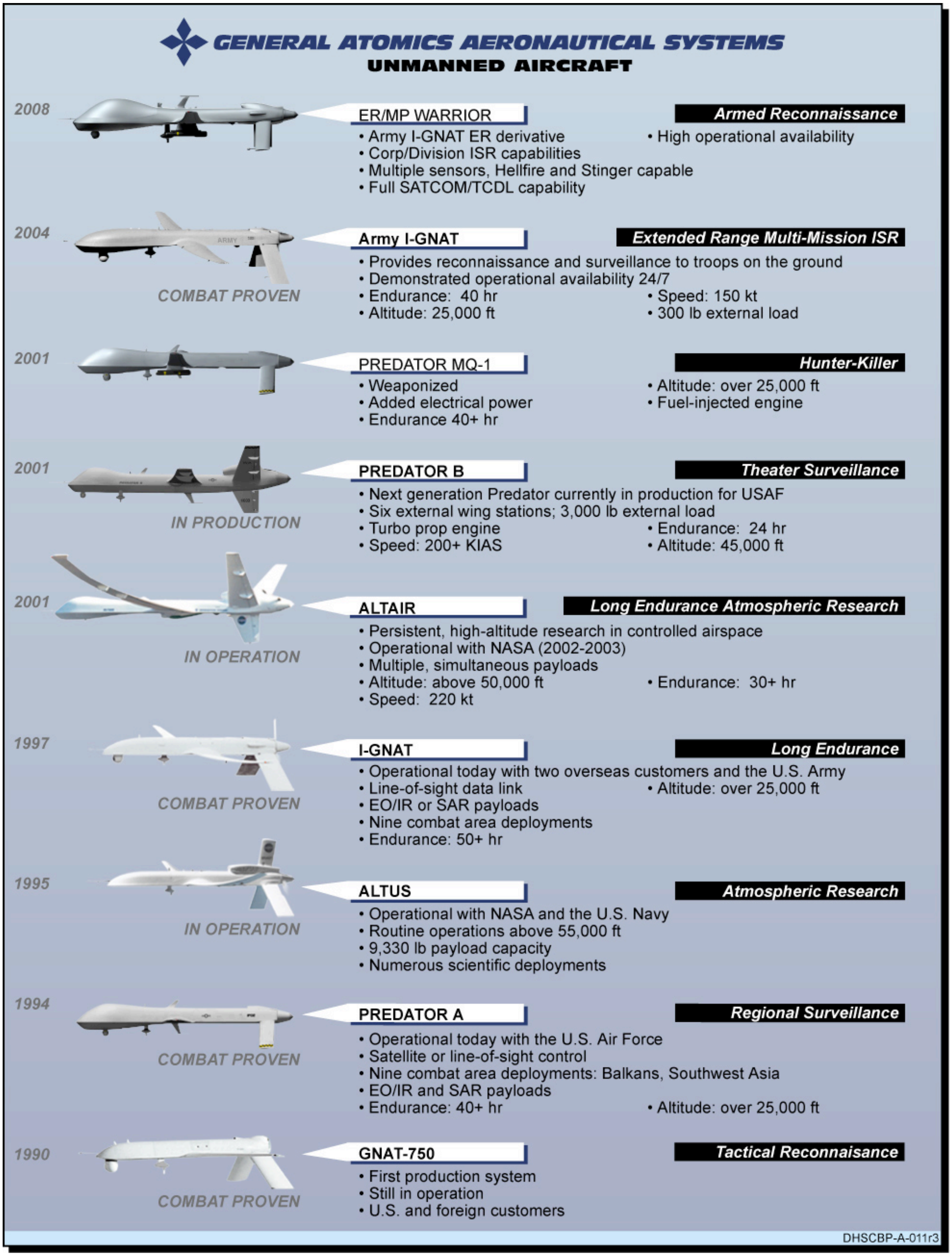

Figure 5.0-1 GA-ASI UAV Family. ***GA-ASI developed a family of unmanned aircraft systems based on planned, controlled growth and continued upgrade of a successful, open system architecture.***

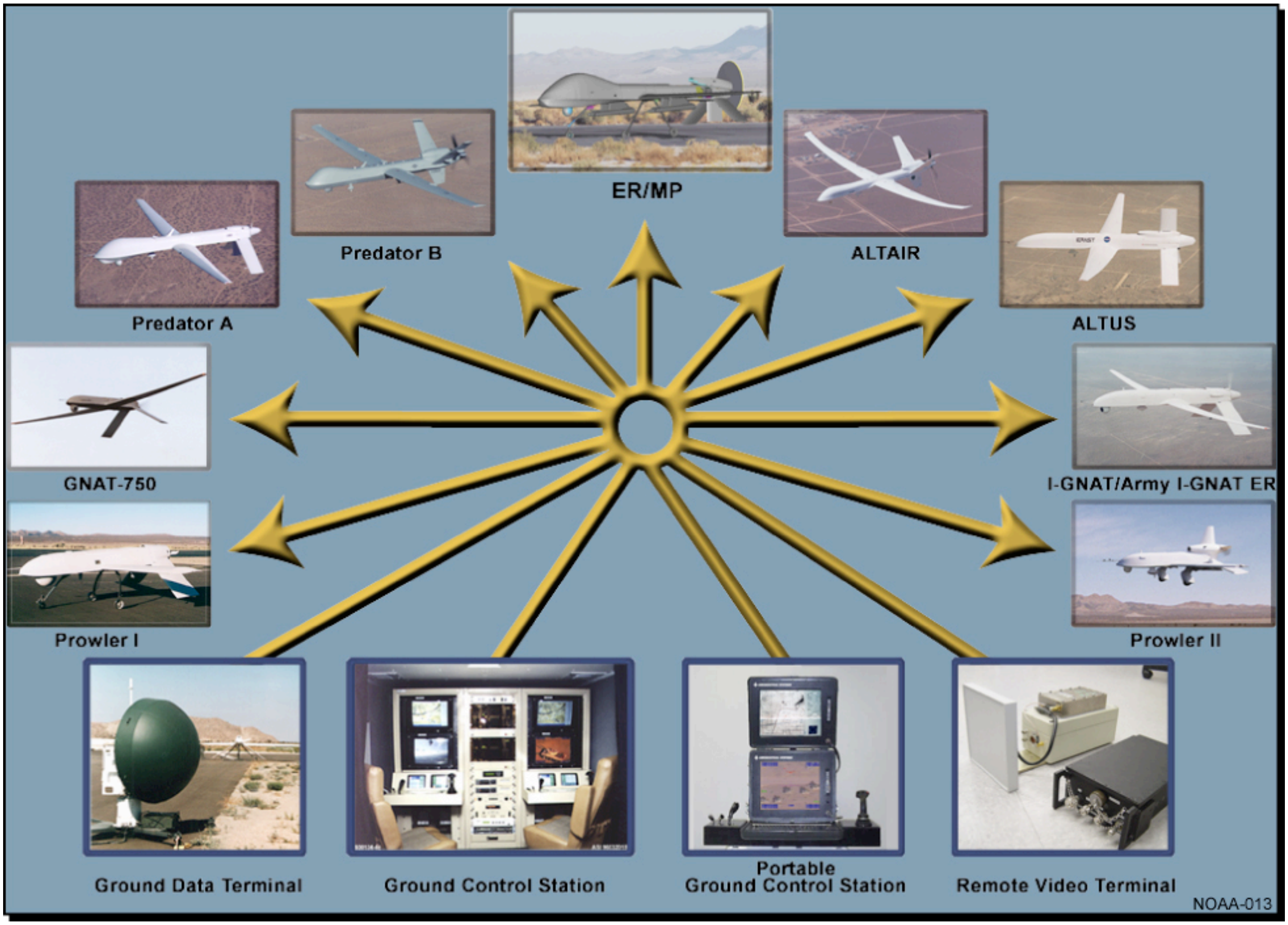

Figure 5.0-2 GA-ASI Innovation. ***In less than 10 years we became a recognized world leader in development and production of UAV systems and an industry pioneer in payload and weapons integration.***

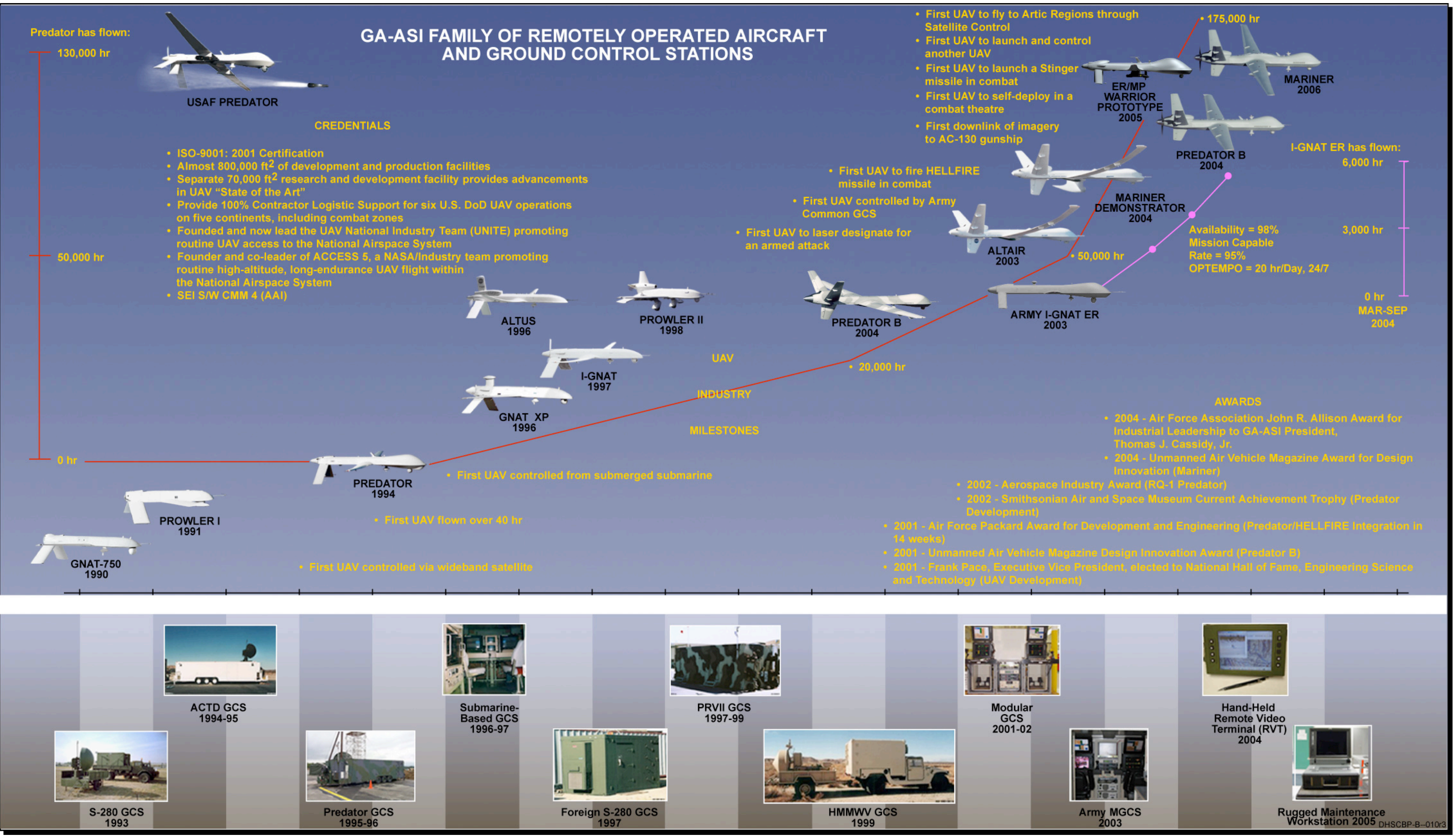

Figure 5.0-3 GA-ASI Family of UA Systems. ***GA-ASI has produced 10 different unmanned aircraft and the ground systems to support them in the past 10 years. Eight of its 10 aircraft are in operational service today with U.S. and foreign customers; all our ground systems are operational today.***

7.0 LMCO PAST PERFORMANCE

Lockheed Martin Aeronautics Advanced Development Program flight demonstrations group has been involved with numerous flight demonstrations providing integration insight and support and providing flight test support during flight test execution.

One particular flight demonstration that Lockheed Martin was the prime integrator for was the Automatic Air Collision Avoidance System (ACAS) flight demonstration. For the ACAS flight demonstration, the integration planning identified that a ground station would be required that would act as a virtual aircraft and communicate the necessary information over the data link hardware to the host aircraft simulation so that the ACAS algorithm could be evaluated on the aircraft hardware in the simulator environment. The ground station allowed the flexibility to set up the virtual aircraft in all kinds of geometries with respect to the host aircraft and allowed the ability to repeat identical runs during testing. In addition, the ground station was utilized in the initial flights to validate the system and provide a safe evaluation. This was a requirement of the safety plan before two aircraft were allowed to perform an ACAS run. The ground station also allowed the flight test group to perform test runs at conditions that would not be allowed for two actual aircraft. Also, the cost savings and ease of running the ground station as opposed to having two aircraft set up for the same kind of runs was dramatic.

From the development produced in the ground station on ACAS, Lockheed Martin Aeronautics proposed that the ground station application could be modified to provide a mobile display for the multiple test environments and collision avoidance applications planned for the Access 5 CCA development and demonstrations. Thus, the concept of the common tool was conceived. The CCA display was developed and the external interface to the common tool was defined to allow TCAS and ADS-B information to be brought in via the Proteus ground station by way of the link to the Proteus aircraft. The CCA display was integrated into the Proteus ground station control room and was an integral part of the collection and display of the collision avoidance data for all of the Access5 CCA flight technology demonstration flight test runs. LM personnel provided integration support and debugged anomalies with the common tool during ground test and preliminary integration check out flights.

Lockheed Martin personnel have the experience to again tailor the common tool to the requirements prescribed for the notional AOD demonstration.

8.0 PRICING

The total cost to fly this CCA Demo and AOD is $2,293,000.00. A complete breakdown of work tasks and can be found in the WBS, Appendix B. Charts 8.0-1 and 8.0-2 depict costs per company/organization for both the CCA demo and AOD flight in the NAS.

8.1 CCA Demo and AOD Mission Cost per Company/Org

GA-ASI	CCA Demo	$ 900,000.00
	AOD Mission	$ 97,000.00
LMCO	CCA Demo	$ 310,950.00
	AOD Mission	$ 54,300.00
NASA	CCA Demo	$ 637,800.00
	AOD Mission	$ 38,850.00
MTSI / Aerovironment	CCA Demo	$ 195,150.00
	AOD Mission	$ 42,450.00
Pb Solutions	AOD Mission	$ 16,600.00
	Total	**$2,293,100.00**

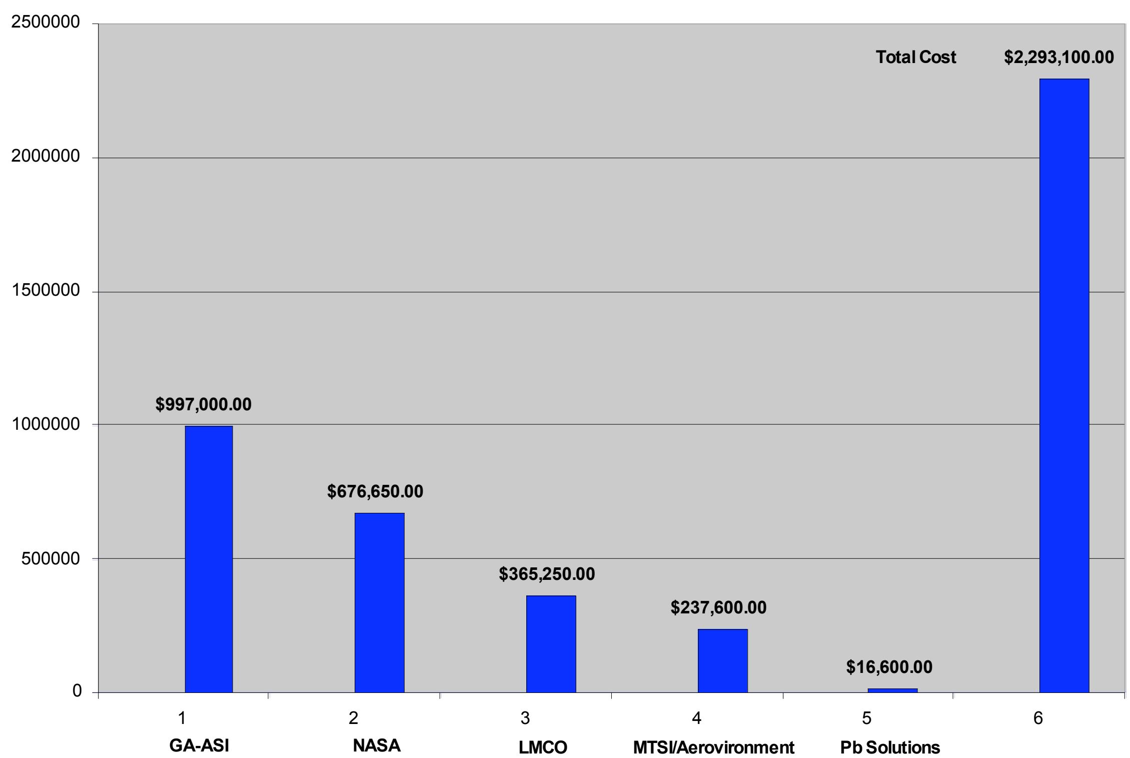

Chart 8.0-1 CCA/AOD Cost Per Company/Organization

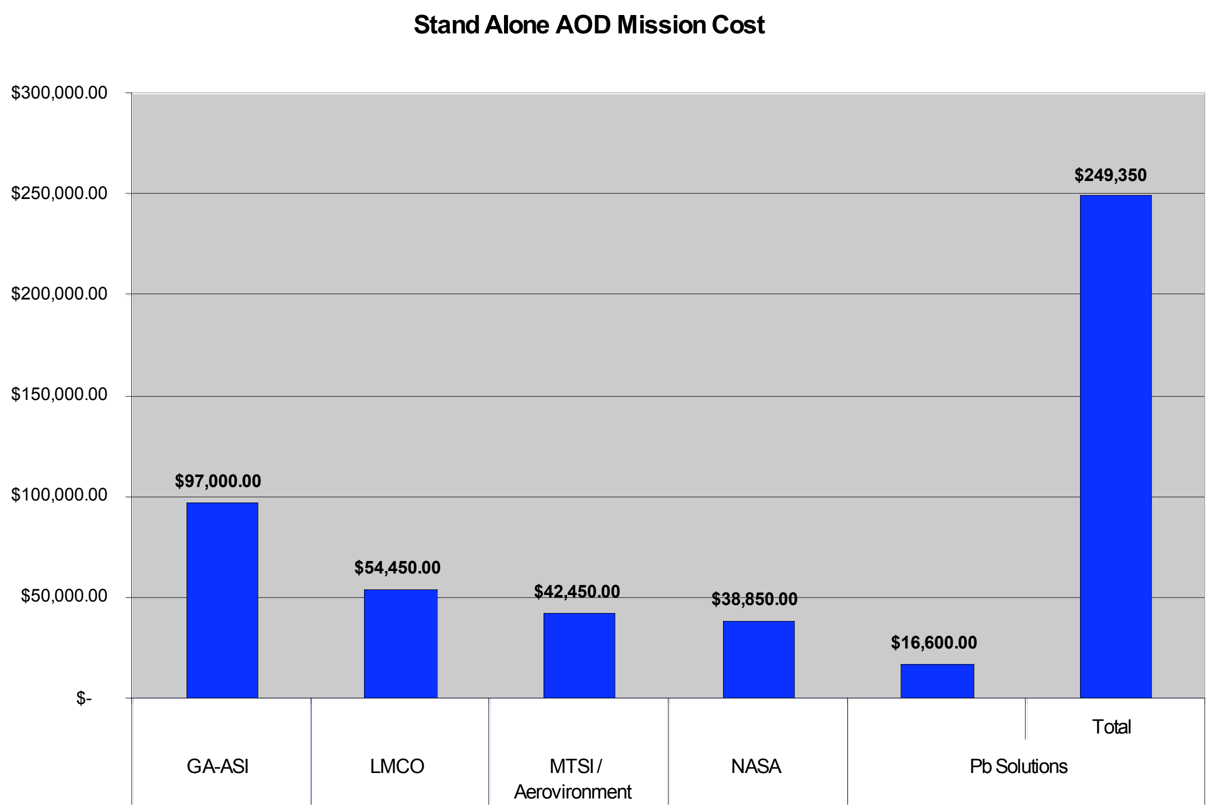

Chart 8.0-2 Stand Alone AOD Mission Cost

9.0 SUMMARY

The AOD was intended to show that the Access 5 Step 1 functional requirements can be met. The demonstration would occur in two phases. The initial on-range phase would be carried out in restricted airspace to demonstrate the CCA functional requirements and to provide risk-reduction for the AOD by allowing the test team to rehearse some elements of the demonstration mission. The CCA system to be used in these flights is based on ADS-B which is a commercially-available system by which airplanes constantly broadcast their current position and altitude to other aircraft and ground resources over a dedicated radio datalink. The final phase will occur in the NAS and will be the formal demonstration of the remainder of the proposed functional requirements.

The general objectives of the AOD are as follows:

- Demonstrate that the UAS can aviate in the NAS
- Demonstrate that the UAS can navigate in the NAS
- Demonstrate that the UAS can communicate with the NAS
- Demonstrate that the UAS can perform selected collision avoidance functions in the NAS
- Demonstrate that the UAS can evaluate and avoid weather conflicts in the NAS

- Demonstrate that the UAS C2 provide adequate command and control in the NAS

The total cost to fly CCA/AOD is $2,293,000.00. However, the final phase, the NAS demonstration can be flown on its own for a cost of $249,350.00.

Figure 8.0-1 ALTAIR™ UA in banked turn.

Appendix A THE COMMON TOOL

The common tool provides the flexibility and mobility to insert display applications or provide simulations of many different platforms into multiple test environments. The intent of the common tool is for it to be open to all participants that would want to utilize the tool. Platform developers could insert their own proprietary models themselves and then bring the tool to the test environment and send the aircraft state information over the external interface. The common tool software is developed using the software application tool known as D-Six. D-Six is a PC based simulation environment, developed by Bihrle Applied Research, that combines the graphical interface, analysis tools and flexibility of the simulation development environment with the computational power needed to run complex engineering simulations at real time. The D-Six setup is illustrated in Figure A-1.

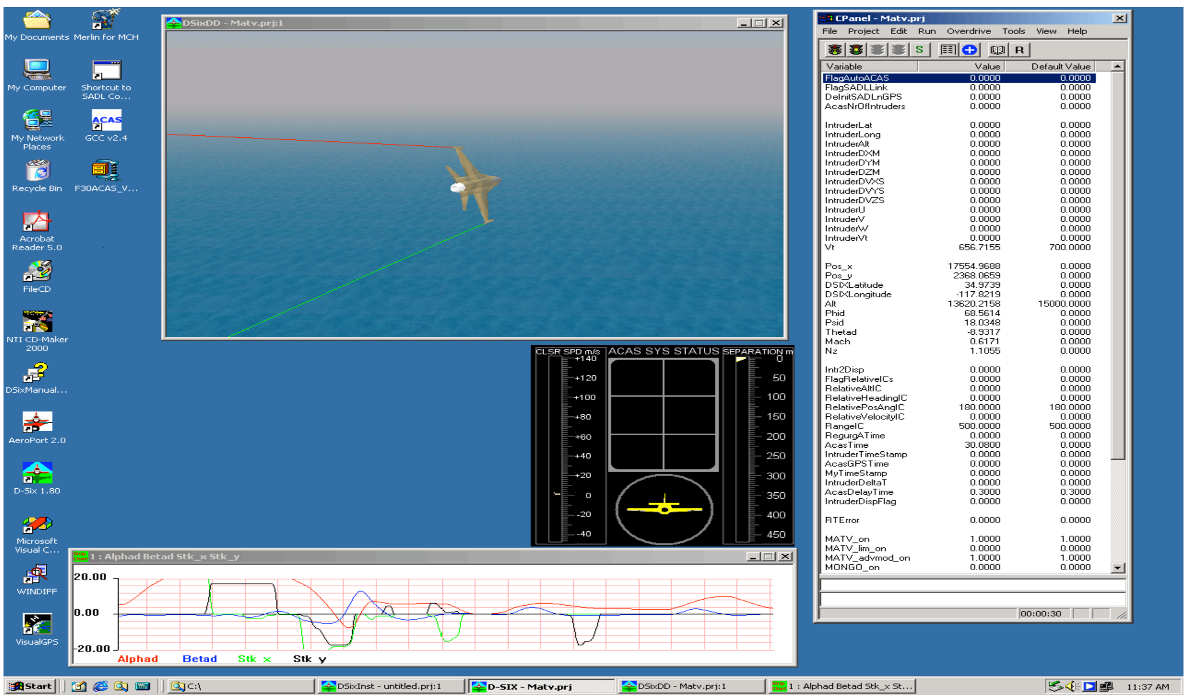

Figure A-1. D-Six Tool Illustration

The collision avoidance display developed as part of the common tool for the CCA Technology Demonstration had several options for the viewer/user to select from. The display allowed the user to choose either TCAS data or ADS-B data for display. A simplified version of the TCAS Collision Avoidance System (CAS) logic was also incorporated as an option to select on the collision avoidance display (Ground CAS logic). The user can select either the ground CAS logic (CAS logic incorporated in the common tool) or take the CAS logic data from the actual TCAS hardware. The user also has the option of selecting a situational awareness display or CAS display when ADS-B data has been requested for display. The overall collision avoidance display processing in the common tool is shown in Figure A-2.

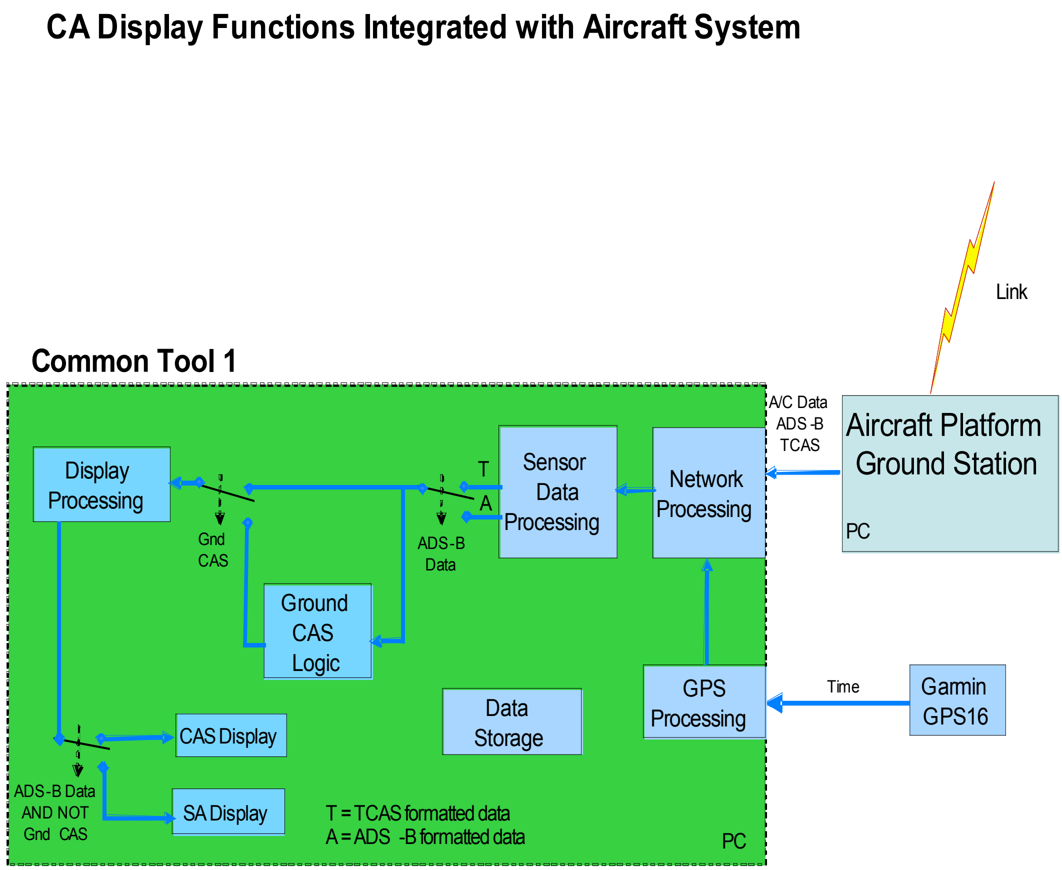

Figure A-2 Collision Avoidance Display Processing

The intent of the common tool was to be able to reuse the collision avoidance display software in multiple software products and lab testing environments with little or no modification to the common tool interfacing source code.

The common tool also provides a generic UAS model that allows for selectable limits of six aircraft performance related parameters. This model could act as a virtual intruder and provide data relative to the host vehicle to drive the collision avoidance display. The virtual intruder setup is defined in Figure A-3. GPS time is also supplied to the common tool to provide for an accurate, reliable, and consistent time stamp that can be associated with the data coming in and being processed.

The primary purpose of the common tool for the AOD is to communicate with the ALTAIR™ ground station and display ADS-B information to the operator. The common tool has been identified to communicate externally with the Altair® ground station via RS-422 or RS-232. A secondary purpose of the common tool is to act as a virtual intruder to allow evaluation and testing of the display without having to add the cost of flying an intruder along with the ALTAIR™ during any in-flight integration testing.

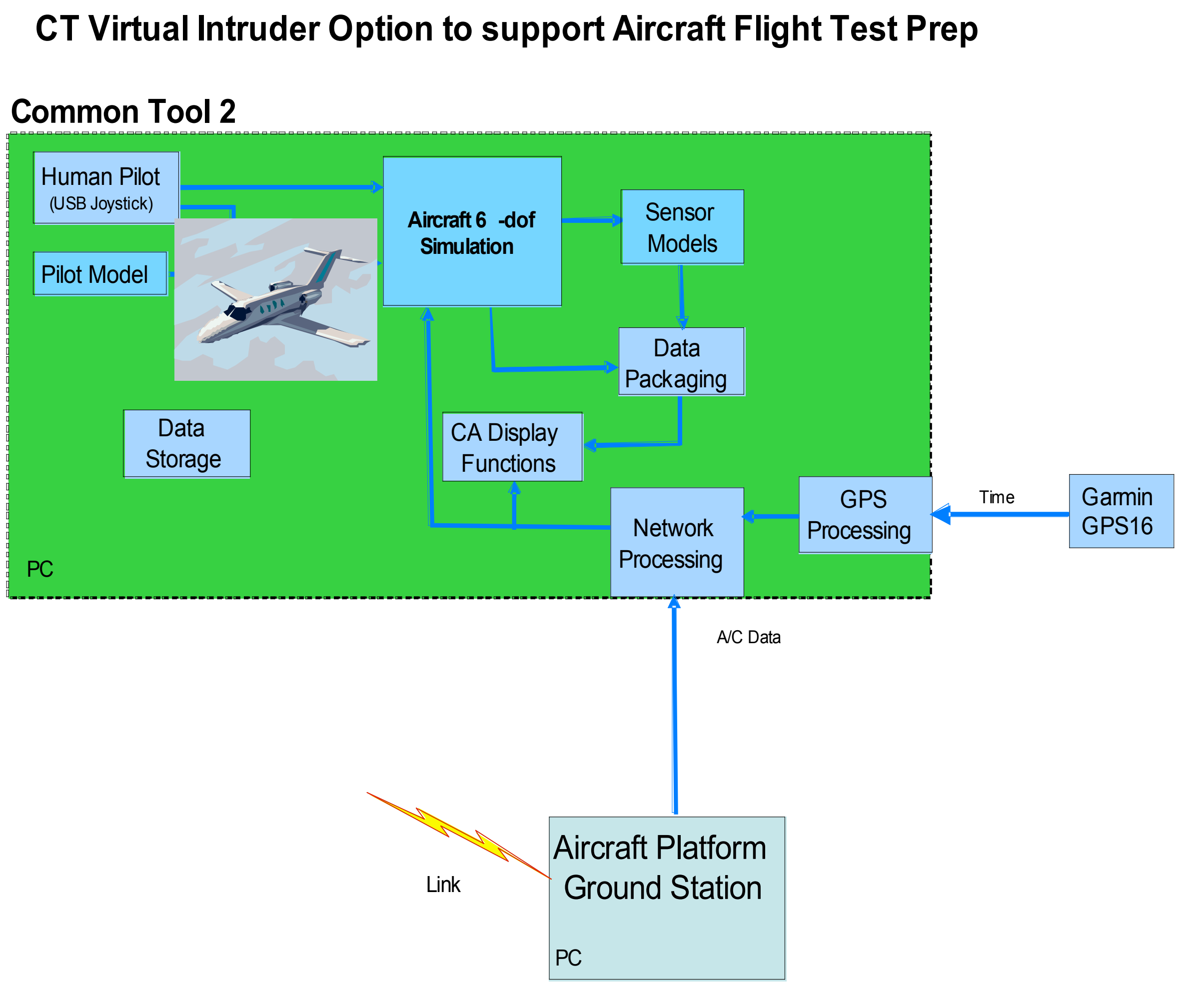

Figure A-3 Virtual Intruder Setup

Appendix B WBS

WBS	Name
1.5.1	**AOD Flight Test**
1.5.1.1	**Develop Test Plan**
1.5.1.1.1	**Define Test Objectives**
1.5.1.1.2	**Develop Data Analysis Plan**
1.5.1.1.3	**Develop test scenarios**
1.5.1.1.4	**Perform safety/hazard analysis**
1.5.1.1.5	**Write Test Plan**
1.5.1.1.6	**FRR**
1.5.1.1.7	**Conduct Flight Approval**
1.5.1.1.8	**Approve Test Plan**
1.5.1.2	**Obtain Test Facilities (CCA increment)**
1.5.1.2.1	**Define Facility requirements**
1.5.1.2.2	**Obtain Maintenance Facilities**
1.5.1.2.3	**Obtain Office Space & Supplies**
1.5.1.2.4	**Obtain AVCS facilities**
1.5.1.3	**Coordinate Airspace**
1.5.1.3.1	**Down select test ranges**
1.5.1.3.2	**Phone Interviews with range manager**
1.5.1.3.3	**Brief Range coordinator with test plan**
1.5.1.3.4	**Get approval/authorization to conduct test**
1.5.1.4	**Coordinate Frequency Spectrum**
1.5.1.4.1	**Control Link(s)**
1.5.1.4.2	**Sensors**
1.5.1.5	**Procure Test Platform(s)**
1.5.1.5.1	**Platform & AVCS Selection**
1.5.1.5.2	**Intruder Aircraft Selection**
1.5.1.6	**Integrate Components**
1.5.1.6.1	**Common Test Tool Development**
1.5.1.6.2	**Platform Specific Interface Coord**
1.5.1.6.3	**Supply Simplified Non-Prop Model**
1.5.1.6.4	**Install Instrumentation**
1.5.1.6.5	**Install CCA subsystem**
1.5.1.6.6	**Install C3 subsystem**
1.5.1.6.7	**Install Communication subsystem**
1.5.1.6.8	**Configuration Control**
1.5.1.7	**Ground Test complete system**
1.5.1.7.1	Develop specific ground test cases
1.5.1.7.2	Prepare hardware/software for ground test

1.5.1.7.3	Execute ground testing
1.5.1.7.4	Document results and improvement needs
1.5.1.8	**Conduct Training**
1.5.1.8.1	**Train Maintainers on the system**
1.5.1.8.2	**Train Flight crews on the system**
1.5.1.8.3	**Train Test engineers on the system**
1.5.1.8.4	**Conduct mission training**
1.5.1.9	**Execute Flight Test**
1.5.1.9.1	**Conduct Tech Review**
1.5.1.9.2	**Conduct Pre-Brief**
1.5.1.9.3	**Conduct CCA Flight Test**
1.5.1.9.4	**Conduct Prep Flight Test**
1.5.1.9.5	**Conduct AOD Flight Test**
1.5.1.10	**Conduct Analysis**
1.5.1.10.1	**Retrieve data from test platform & Intruder aircraft**
1.5.1.10.2	**Retrieve data from AVCS**
1.5.1.10.3	**Retrieve ARSR radar data from FAA ARTCC**
1.5.1.10.4	**Package sensor & TSP data**
1.5.1.10.5	**Analyze Flight Data to confirm test objectives met**
1.5.1.10.6	**Conduct CCA Analysis**
1.5.1.10.7	**Catalogue Data and Compile Tracking Matrix**
1.5.1.11	**Write Test Report**
1.5.1.11.1	**Write Quick Look Report**
1.5.1.11.2	**Write Interim Report**
1.5.1.11.3	**Write Final Report**
1.5.1.11.4	**Analysis Coordination**
1.5.1.11.5	**Document Coordination**
1.5.1.11.6	**Publication**
1.5.1.11.7	**CCA Reporting**
1.5.1.12	**Management**
1.5.1.12.1	**Coordination**
1.5.1.12.2	**Tracking**
1.5.1.12.3	**Reporting**

Appendix C GA-ASI, LMCO, NASA, Pb Solutions, MTSI and Aerovironment Pricing

Combined CCA Demo AOD Mission Cost per Company / Organization

GA-ASI	CCA Demo		$ 900,000.00
	AOD Mission		$ 97,000.00
LMCO	CCA Demo		$ 310,950.00
	AOD Mission		$ 54,300.00
NASA	CCA Demo		$ 637,800.00
	AOD Mission		$ 38,850.00
MTSI / Aerovironment	CCA Demo		$ 195,150.00
	AOD Mission		$ 42,450.00
Pb Solutions	AOD Mission		$ 16,600.00
		Total	**$2,293,100.00**

Stand Alone AOD Mission Cost

GA-ASI		$ 97,000.00
LMCO		$ 54,450.00
MTSI / Aerovironment		$ 42,450.00
NASA		$ 38,850.00
Pb Solutions		$ 16,600.00
	Total	**$ 249,350**

Appendix D Pb Solutions ROM

February 3, 2006
Reference; Pb06-FT007

National Aeronautics and
Space Administration
Dryden Flight Research Center
P.O. Box 273 MS 2344
Edwards, CA 93523-0273

Attention: Mr. Mike Sakahara

Subject: Cost to Provide Briefings on Technology Flight Demonstration for CCA and Airspace Operations Demonstration (AOD) Plan to FAA.

Reference: a) SEIT Request to provide Costing for AOD Plan briefings to FAA

Attachment: None

Dear Mr. Sakahara,

In response to the request to provide a cost estimate to provide briefing to the FAA on the Technology Flight Demonstration for CCA and Airspace Operations Demonstration (AOD) Plan, Pb Solutions is pleased to provide the following:

1. Labor	**$14,000**
2. Travel	**$ 2,600**
	$16,600

In order to provide a potential customer with the tasks associated with this estimate, Pb Solutions provides the following:

2. Breakdown of cost to provide briefings on Technology Flight Demonstration for CCA and Airspace Operations Demonstration (AOD) Plan to FAA.

    A. Total labor hours to prepare brief and handouts: **16 hours**
    B. Labor hours associated with providing briefs to FAA: **77 hours**

Pb Solutions will provide:

I. A Power Point brief and handouts explaining the Technology Flight Demonstration for CCA and Airspace Operations Demonstration (AOD) Plan:

II. An expert briefer with extensive experience in the background and development of the AOD plan at all four briefs.

This cost estimate for the proposed AOD is for budgetary and planning purposes only and does not constitute a formal offer. It is based on FY-06 dollars.

This proposal includes data that shall not be disclosed to any third party and shall not be duplicated, used or disclosed, in whole or part, for any purpose other than to evaluate this program opportunities.

The choice of Pb Solutions is the low risk, high payoff solution to the request. If you have any questions regarding this communication, please contact me at (858) 414-5167.

Pb Solutions is a registered Disabled Veterans Business Enterprise (DBVE # 32546).

Sincerely,

Nicholas A. Trongale
President
Pb Solutions

Pb Solutions, 250 E. Church St. Elmhurst, IL 60126
Phone: 858-414-5167

Appendix E Access 5 Glossary of Terms

Purpose: This Glossary was compiled to promote a common understanding of the most ambiguous terms used by the members of the Access 5 Group during their Integration of Unmanned Aircraft into the National Airspace system (NAS) effort.

AIRCRAFT − A device that is used, or intended to be used, for flight in the air.

AIRCRAFT CONTROL STATION (ACS) − The equipment from which the pilot of an unmanned aircraft (UA) remotely controls and monitors the UA flight and mission activity.

AIRWORTHINESS - The condition in which the UAS conforms to its type certificate and is in condition for safe operation.

AUTONOMOUS OPERATIONS – The method whereby the control of an unmanned aircraft is accomplished by an onboard self-contained flight management control system using previously inserted data.

CERTIFICATE OF AUTHORIZATION OR WAIVER (COA) - An FAA grant of approval for a specific operation, for a specified time period.

CIVIL AIRCRAFT – An aircraft other than public aircraft.

CODE OF FEDERAL REGULATION – A codification of the general and permanent rules published in the Federal Register by the Executive department and agencies of the Federal Government. Pertinent to aviation are those rules issued by the department of Transportation and the Federal Aviation Administration (see Title 14 Code of Federal Regulations parts 1-499).

COLLISION AVOIDANCE (CA) - Averting physical contact between an aircraft and any other object or terrain.

COMMAND LINK - The element of the unmanned aircraft system used to transfer a pilot's intent to the unmanned aircraft. The uplink portion of the control link between a pilot and the unmanned aircraft.

COMMUNICATIONS LINK - The element of the unmanned aircraft system used for voice and/or digital communications between a UA pilot and ATC. Includes an uplink and downlink component. Often implemented as part of the control link.

CONTROL LINK - The element of the unmanned aircraft system used by the UA pilot to fly the aircraft. Consists of the command link (uplink) and the status link (downlink).

COOPERATIVE SENSE AND AVOID SYSTEM (CSAS) – A system capable of communicating with systems on board other aircraft, or other airborne objects in order to facilitate detection or coordinate resolution maneuvers, or both.

DATA LINK - A term referring to all links between an unmanned aircraft and the aircraft control station. It includes control, communications and payload links..

EQUIVALENT LEVEL OF SAFETY (ELOS) - An evaluation, often subjective, of a system and/or operation to determine the acceptable risk to people and property.

FLIGHT RECOVERY SYSTEM - Incorporating some feature for automatically counteracting the effect of an anticipated possible source of failure.

HIGH ALTITUDE LONG ENDURANCE (HALE) – An unmanned aircraft capable of performing a specific mission at a specified altitude at or above flight level 450 over a period of 24 hours or more.

HOLDING – A predetermined maneuver that keeps aircraft within a specified airspace. Also used during ground operations to keep aircraft within a specified.

LATENCY - The time incurred between two particular interfaces. The total latency is the delay between the true time of applicability of a measurement and the time that the measurement is reported at a particular interface (the latter minus the former).

LINK FAILURE – The loss of command and/or status link between a pilot and an unmanned aircraft.

LINK INTERRUPTION – An occurrence when either the unmanned aircraft or the aircraft control station detects the loss of the command and/or status link. Link Interruption becomes Link Failure if the loss of link lasts longer than a predefined interval.

LOITERING – (See HOLDING).

LOST COMMUNICATIONS – Loss of the ability to communicate by radio.

MODEL AIRCRAFT - A model aircraft is a non-human-carrying device capable of sustained flight in the atmosphere and is intended to be used exclusively for recreational or competition activity. The maximum takeoff weight of a model aircraft, including fuel, is 55 pounds, except for those flown under the AMA Experimental Aircraft Rules.

NON-COOPERATIVE SENSE AND AVOID – A system that is capable of detecting aircraft, or other airborne objects that do not have a cooperative sense and avoid system.

PAYLOAD LINK - The element of the unmanned aircraft system used for control of payload equipment (e.g. cameras, sensors, deployable devices). Includes an uplink for control of payload equipment and a downlink for data collection.

PILOT IN COMMAND − The pilot responsible for the operation and safety of an aircraft during flight.

PUBLIC USE AIRCRAFT – An aircraft used only for the U.S. Government, or owned and operated (except for commercial purposes) , or exclusively leased for at least 90 continuous days, by a government (except the U.S. Government) including a State, the District of Columbia, or a territory or possession of the U.S. , or political subdivision of that government.

REMOTELY OPERATED AIRCRAFT (ROA) – (See UNMANNED AIRCRAFT).

REMOTELY PILOTED VEHICLE (RPV) - (See UNMANNED AIRCRAFT).

SEE AND AVOID− When weather conditions permit, pilots operating on instrument or visual flight rules are required to observe and maneuver to avoid other aircraft. Right-of-way rules are contained in 14 CFR part 91.

SENSE AND AVOID – The ability to detect conflicting object(s) and take the appropriate action to avoid a collision with said object(s).

SPECIAL USE AIRSPACE − Regulatory (Prohibited area or Restricted) or non-regulatory (alert area, control firing area, military operations area, warning area) Airspace of defined dimensions identified by an area on the surface of the earth wherein activities must be confined because of their nature and/or wherein limitations may be imposed upon aircraft operations that are not a part of the activity on the ground or in the air so as to eliminate hazards to nonparticipating aircraft and to ensure the safety of persons and property on the ground.

STATUS LINK – The element of the unmanned aircraft system that provides a UA pilot with the operational status of the aircraft. The downlink portion of the control link between a pilot and an unmanned aircraft.

TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM (TCAS) - Airborne collision avoidance system based on radar beacon signals which operates independent of ground-based equipment.

TRANSPONDER − The airborne radar beacon receiver/transmitter portion of the Air Traffic Control Radar Beacon System that automatically receives radio signals from interrogators on the ground, and selectively replies with a specific reply pulse or pulse group only to those interrogations being received on the mode to which it is set to respond.

UNMANNED AIRCRAFT (UA) – A powered, aerodynamic aircraft with an integral recovery/landing system that is operated without a pilot onboard.

UNMANNED AIRCRAFT SYSTEM (UAS) – An unmanned aircraft and its associated elements required for operation, including the various links and aircraft control station.

UNMANNED AIR VEHICLE (UAV) - (See UNMANNED AIRCRAFT).