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UAS Integration in the NAS Project

INTEGRATED TEST AND EVALUATION (IT&E)

FLIGHT TEST SERIES 4

Flight Test Plan

IT&E FT4 FTP-01

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SIGNATURES

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REVISION SHEET

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1 Introduction

The desire and ability to fly Unmanned Aircraft Systems (UAS) in the National Airspace System (NAS) is of increasing urgency. The application of unmanned aircraft to perform national security, defense, scientific, and emergency management are driving the critical need for less restrictive access by UAS to the NAS. UAS represent a new capability that will provide a variety of services in the government (public) and commercial (civil) aviation sectors. The growth of this potential industry has not yet been realized due to the lack of a common understanding of what is required to safely operate UAS in the NAS.

NASA's UAS Integration into the NAS Project is conducting research in the areas of Separation Assurance/Sense and Avoid Interoperability, Human Systems Integration (HSI), and Communication to support reducing the barriers of UAS access to the NAS. This research is broken into two research themes namely, UAS Integration and Test Infrastructure. UAS Integration focuses on airspace integration procedures and performance standards to enable UAS integration in the air transportation system, covering Detect and Avoid (DAA) performance standards, command and control performance standards, and human systems integration. The focus of Test Infrastructure is to enable development and validation of airspace integration procedures and performance standards, including the integrated test and evaluation. In support of the integrated test and evaluation efforts, the Project will develop an adaptable, scalable, and schedulable relevant test environment capable of evaluating concepts and technologies for unmanned aircraft systems to safely operate in the NAS.

To accomplish this task, the Project will conduct a series of Human-in-the-Loop and Flight Test activities that integrate key concepts, technologies and/or procedures in a relevant air traffic environment. Each of the integrated events will build on the technical achievements, fidelity and complexity of the previous tests and technical simulations, resulting in research findings that support the development of regulations governing the access of UAS into the NAS.

1.1 Purpose

The integrated Flight Test 4 (FT4) will gather data for the UAS researchers Sense and Avoid systems (referred to as Detect and Avoid in the RTCA SC 228 ToR) algorithms and pilot displays for candidate UAS systems in a relevant environment. The technical goals of FT4 are to: 1) perform end-to-end traffic encounter test of pilot guidance generated by DAA algorithms; 2) collect data to inform the initial Minimum Operational Performance Standards (MOPS) for Detect and Avoid systems.

FT4 objectives and test infrastructure builds from previous UAS project simulations and flight tests. NASA Ames (ARC), NASA Armstrong (AFRC), and NASA Langley (LaRC) Research Centers will share responsibility for conducting the tests, each providing a test lab and critical functionality. UAS-NAS project support and participation on the 2014 flight test of ACAS Xu and DAA Self Separation (SS) significantly contributed to building up infrastructure and procedures for FT3 as well.

The DAA Scripted flight test (FT4) will be conducted out of NASA Armstrong over an eight-week period beginning in April 2016.

Test facilities are Government owned, managed, leased, or under agreement and fall into two categories:

Development Facilities:

- Distributed System Research Laboratory (DSRL) at NASA Ames
- Flight Deck Display Research Laboratory (FDDRL) at NASA Ames
- Research Aircraft Integration Facility (RAIF) at NASA Armstrong
- UAS Sense and Avoid Research Lab at NASA Langley
- GA-ASI Grey Butte Flight Test Facility
- GA-ASI System Integration Lab

Test Facilities:

- Crew Vehicle Simulation Research Facility (CVSRF) at NASA Ames
- Distributed System Research Laboratory (DSRL) at NASA Ames
- Air Traffic Operations Laboratory (ATOL) at NASA Langley
- Research Aircraft Integration Facility (RAIF) at NASA Armstrong
- Dryden Aeronautical Test Range (DATR) at NASA Armstrong
- Stand Alone Facility (SAF) at NASA Armstrong
- The Radio Frequency (RF) Communications facility at NASA Armstrong
- Edwards R-2508 Complex

1.2 Stakeholders, Participants, and Responsibilities

NASA Integrated Aviation Systems Program (IASP) provides direction for the UAS in the NAS project. The project office has overall responsibility for FT4 flight test. NASA Ames, NASA Armstrong, NASA Glenn, NASA Langley, GA-ASI and Honeywell support the project and with the exception of NASA Glenn are participants in the FT4 activity. The following is a brief description of responsibilities:

- **NASA Ames Research Center (ARC):** NASA Ames is responsible for providing one of the DAA systems (Java Architecture for DAA Extensibility and Modeling (JADEM)) to be used during DAA scripted flight test. Further, ARC is responsible for the development and testing of the LVC infrastructure, as well as the integration of the DAA software with the various hardware and software systems used during flight test. The LVC Gateway enables data distribution among all of the other NASA centers involved in the project, as well as to remote users (through RUMS).

- **NASA Armstrong Flight Research Center (AFRC):** NASA Armstrong is the responsible test organization for all test missions flown from AFRC. Further AFRC is responsible for hosting and supporting the Live Virtual Constructive (LVC) infrastructure for hosting data distribution between NASA Ames, and Langley. AFRC is also responsible for providing the live unmanned aircraft (ownship) to be used during DAA scripted encounters within R-2515 airspace. In addition to providing the UAS ownship aircraft, AFRC will also provide intruder aircraft (T-34, King Air and G-III) as required.

- **NASA Langley Research Center (LaRC):** NASA Langley is responsible for providing a DAA system (Detect & AvoID Alerting Logic for Unmanned Systems (DAIDALUS)) that will be displayed and evaluated by subject pilots during flight encounters.

- **General Atomics Aeronautical Systems Inc. (GA-ASI):** Is responsible for providing hardware, software and integration support on the NASA Ikhana UAS. GA-ASI will provide DAA scripted encounter requirements (CPDS) for autonomous aircraft response maneuvers.

- **Honeywell (HW):** Honeywell is providing the software for the Surveillance Tracking Module (STM) prototype that contains the Honeywell Fusion Tracker. Honeywell will also provide the primary Traffic Alert and Collision Avoidance System (TCAS) II equipped intruder aircraft to support DAA scripted flight test encounters. The Honeywell intruder aircraft is capable of onboard TCAS data recording.

- **RTCA Special Committee (SC) -228:** Is responsible for providing inputs on planned scripted encounters and will provide encounters with unique configurations, geometries and setups that are not covered by the other stakeholders. Their encounters will complement the data set being collected by the other stakeholders and will better inform the overall MOPS development efforts.

1.3 Requirements Flow & Documentation

Requirements flow and documentation for FT4 are identified in Figure 1. Project documents are archived in the UAS NAS folder located on NSC Knowledge Now information management tool.

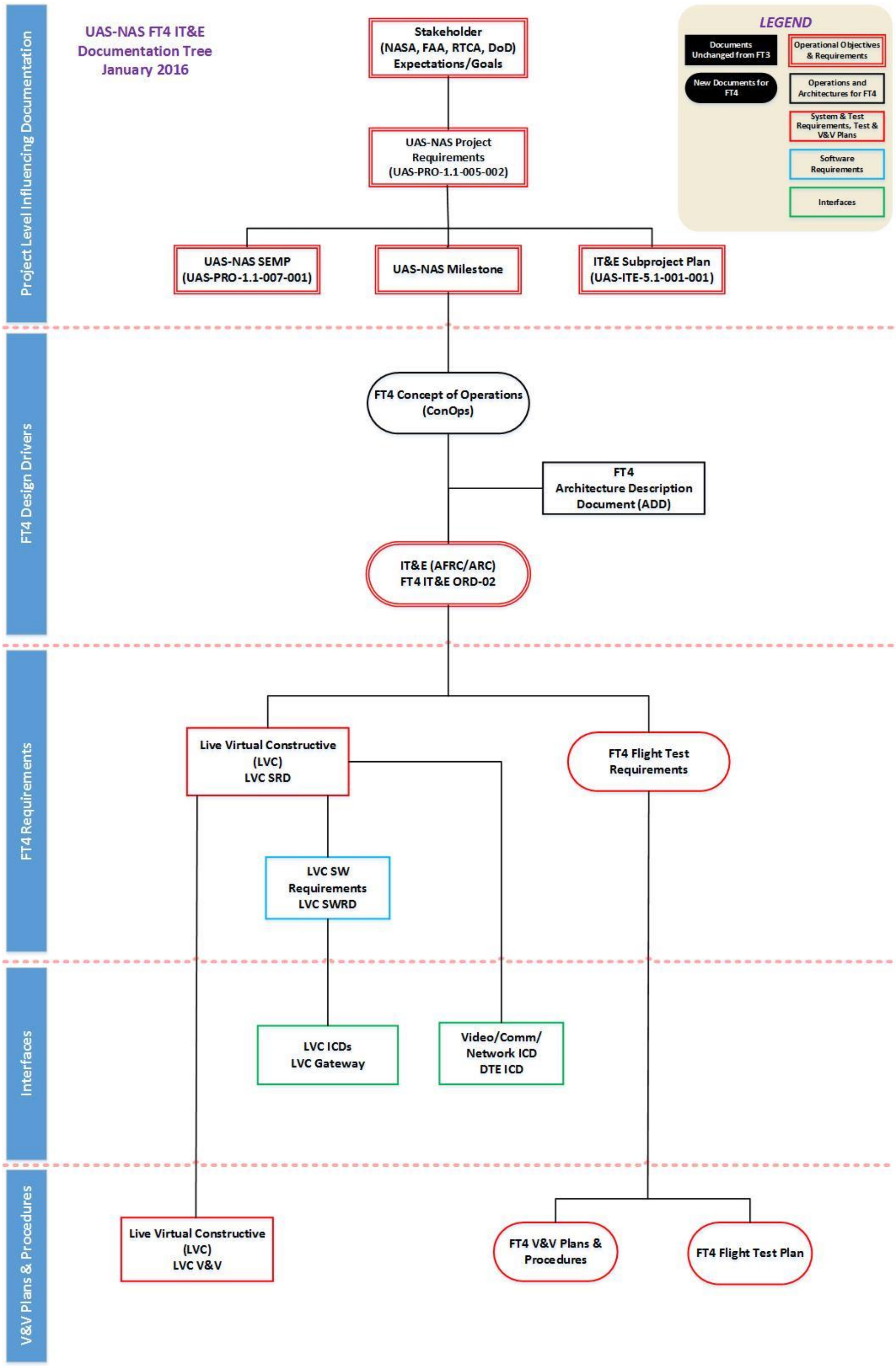


Figure 1. UAS-NAS IT&E Document Tree.

2 ConOps

2.1 Concept Overview

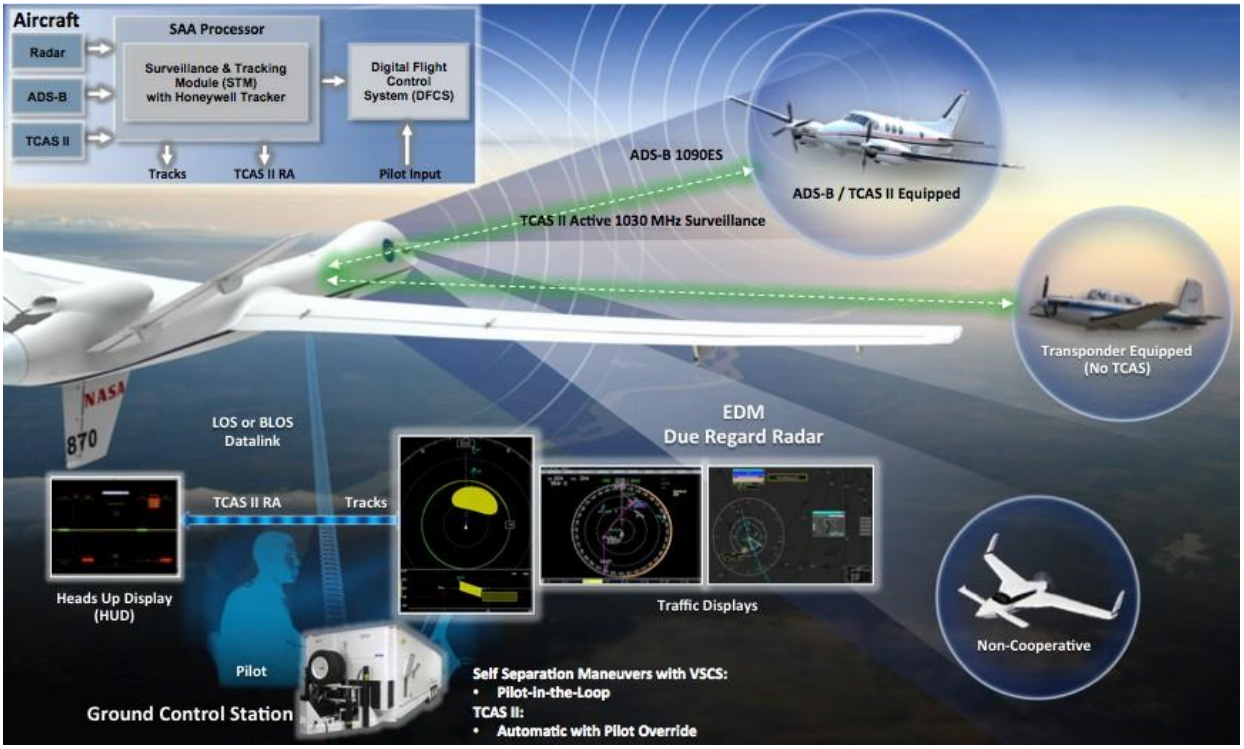


Figure 2. FT4 Concept of Operations.

The concept for FT4 is to create an experimental flight environment that simulates Class E airspace and fly Cooperative and Non-Cooperative intruder aircraft at speeds representative of commercial passenger and general aviation aircraft to support data collection for Researchers involved in the SC-228 DAA System MOPS development.

The CONOPS for FT4 leverages from the IHITL, ACAS-Xu and FT3 efforts. The FT3 Configuration 1 ("Pairwise Encounters") test scenarios where low-speed and high-speed flight testing was conducted with intruder aircraft in a relevant flight environment will be enhanced and implemented for FT4 (Figure 2). FT4 will meet this intent by integrating new DAA Systems technology, where the availability of documentation is limited, with existing systems (e.g., TCAS, ADS-B) to demonstrate engineering feasibility in actual system application.

In FT4, the test scenarios will be referred to as "DAA Scripted Encounters". Similar to FT3, FT4 will fly the DAA systems under test (SUT) to provide the data needed by researchers for V&V of their models and algorithms so that they in turn can inform the RTCA SC-228 of their results towards supporting development of the MOPS for a DAA system.

FT4 will be configured to continue the evaluation of advisories generated by the SS and CA Algorithms fed by data from live aircraft during flight. DAA Scripted Encounters will involve flight encounters using an unmanned (UAS) ownship aircraft against both low and high-speed manned intruder aircraft. In these tests, a UAS ownship aircraft will be flown against either one or multiple manned intruder aircraft, under carefully designed flight path trajectories to induce DAA alerting. And, based on specific test cases, vertical and horizontal maneuvering will also be performed for data collection.

Three DAA algorithms will be evaluated:

1) Detect & AvoID Alerting Logic for Unmanned Systems (DAIDALUS) – originally developed by NASA Langley as "Stratway+" to support tactical resolution advisories for manned aircraft. Based on TCAS logic, DAIDALUS determines traffic alert levels and the range of maneuver options that will produce a Loss of Well Clear (LoWC) within a configurable look ahead time. When LoWC occurs, it provides Well Clear Recovery (WCR) guidance bands showing the non-conflicted airspace for WCR to minimize collision risk.

2) JAVA Architecture for DAA Extensibility and Modeling (JADEM) – first developed by NASA Ames as "AutoResolver" to support air traffic controllers with advisories to maneuver aircraft in the Enroute and Terminal airspace based on predicted Loss of Separation (LoS). This algorithm has been modified to work with pilots to receive and evaluate intruder TCAS messages, support Resolution Alerts (RAs) and CA maneuvers in response to LoWC. With the incorporation of the banding module, this has been modified to the OmniBands configuration that applies logic to support DAA/TCAS interoperability as well as WCR guidance.

3) Conflict Prediction and Display System (CPDS) – developed by General Atomics – Aeronautical Systems, Inc. (GA-ASI) and the Technische Universiteit Delft (TUD, Delft University of Technology located in the Netherlands) for Human Factors and user display research. This study seeks to exercise the SS concepts alerting guidance and examine the timing and utility of the alerts under actual flight conditions.

2.2 Differences between FT3 and FT4

2.2.1 FT3

FT3 represented the first instance that a prototype DAA technology, designed for UAS pilots, was flight-tested against other live aircraft in addition to simulated traffic provided through the LVC environment.

FT3 accomplished the gathering of key data for the researchers to help validate their simulation models by flying over 200 carefully scripted and executed flights of the NASA870 Ikhana UAS ownship against single and multiple intruder aircraft. It was during this flight test series that history was made when, for the 1st time, an actual live UAS (Ikhana) was successfully flown against two intruder aircraft and was able to execute the DAA alerts to maintain well clear.

FT3 was executed in two main configurations. The first configuration was "Pairwise Encounters" where the encounters were all one-on-one (or one-on-two) with one ownship and one (or two) intruder(s). The second configuration was designed for "Full Mission Encounters" where the Ikhana UAS ownship, or a Surrogate UAS ownship, was flown against two live intruders and up to five simulated intruders using the LVC simulation environment to "fold" in Oakland airspace (ZOA) with the live flights occurring in Special Use Airspace (SUA) within the restricted airspace range complex of R2508 that covers Edwards Air Force Base (EAFB) and China Lake Naval Weapons Station in southern California near Los Angeles.

Full Mission encounters were unable to be completed due to aircraft integration issues. FT3 intruder aircraft consisted of cooperative and non-cooperative aircraft. Cooperative aircraft carried systems that actively broadcasted their identity, positions and other pertinent data for proximate aircraft that are similarly equipped to receive. Non-cooperative aircraft used did not possess the equipage to actively broadcast their identity, position, etc. to other aircraft and had to be detected by other means for deconfliction. An Air-to-Air Radar was used in FT3 as the active sensor to detect non-cooperative aircraft.

2.2.2 FT4

FT4 represents the latest distributed test activity supporting the UAS-NAS project conducted using the LVC distributed test environment.

The FT4 activities build upon the algorithm development and human factors research conducted in FT3 from June thru August of 2015. FT4 will heavily leverage the LVC environment, aircraft assets, and flight test infrastructure and procedures developed for FT3 (and ACAS Xu prior to FT3) to fast track the FT4 activities. The FT3 efforts originally intended to integrate the DAA technologies into ownship operation, using CNPC for sensor data downlink and to control ownship but this was unable to be accomplished due to technical issues that arose. The FT3 flights probed and verified aspects of the robustness of the DAA algorithm as well as exercising the alerting symbology presented to the UAS pilot. FT4 will also incorporate the lessons learned and system improvements identified during the FT3 testing.

FT4 will be flying the Ikhana as the UAS ownship against multiple intruder aircraft in carefully scripted encounters with the goal to assess for TCAS Interoperability and to collect more data towards validation of the improved DAA and Collision Avoidance (CA) algorithms. These DAA and CA algorithms consist of JAVA Architecture for DAA Extensibility and Modeling (JADEM – formerly AutoResolver), Detect & AvoID Alerting Logic for Unmanned Systems (DAIDALUS – formerly Stratway+) and Conflict Prediction and Display System (CPDS – a General Atomics developed SS algorithm).

Two hardware stakeholders (GA and HON) will be using FT4 to optimize their systems. GA will be working to validate and improve their CPDS system integration with TCAS and radar and HON will be doing the same for their SAAP flight hardware.

Finally, FT4 will also be supporting the SC-228 V&V Subcommittee with their desired test objectives.

2.2.3 Scripted Encounters

FT4 will fly the DAA systems under test (SUT) to provide the data needed by researchers for V&V of their models and algorithms so that they in turn can inform the RTCA SC-228 of their results towards supporting development of the MOPS for a DAA system.

FT4 will be comprised of scripted encounters similar to those of the FT3 Configuration 1. Furthermore, the core stakeholders have increased when compared to FT3. The following core stakeholders have a unique set of scripted encounters designed to capture data that supports the primary objectives.

- SSI, both Langley and Ames Research Centers
- General Atomics including CPDS, Radar development team and TCAS development team
- Honeywell
- SC-228

FT4 includes Honeywell and SC-228 encounters where from FT3 perspective, they did not request to include unique scripted encounters. Additionally, draft MOPS documentation have been released by SC-228. Since the documentation is more mature, SC-228 was able to provide specific use-cases and encounters verify the MOPS as applicable and correct.

The following includes some of the key differences between FT3 and FT4

- TCAS interoperability is being evaluated. This translates to the inclusion of TCAS alerting on both SSI-Ames and SSI-Langley displays as well as the GCS HUD.
- High speed encounters above 10,000 ft MSL are designed around the GIII performance envelope.
- All aircraft will be equipped with DGPS recording equipment for post flight data review.

2.2.4 TCAS II Hybrid Surveillance Description

For Flight Test 4 (FT4), Ikhana will be equipped with a TPA-100B TCAS II Processor with enhanced hybrid surveillance mode enabled. In this mode, the TCAS sensor uses passive surveillance instead of active surveillance to track intruders that meet certain TCAS II Hybrid quality criteria and are not projected to be near-term collision threats as shown in the state transition diagram in Figure 3 (ref. DO-300A).

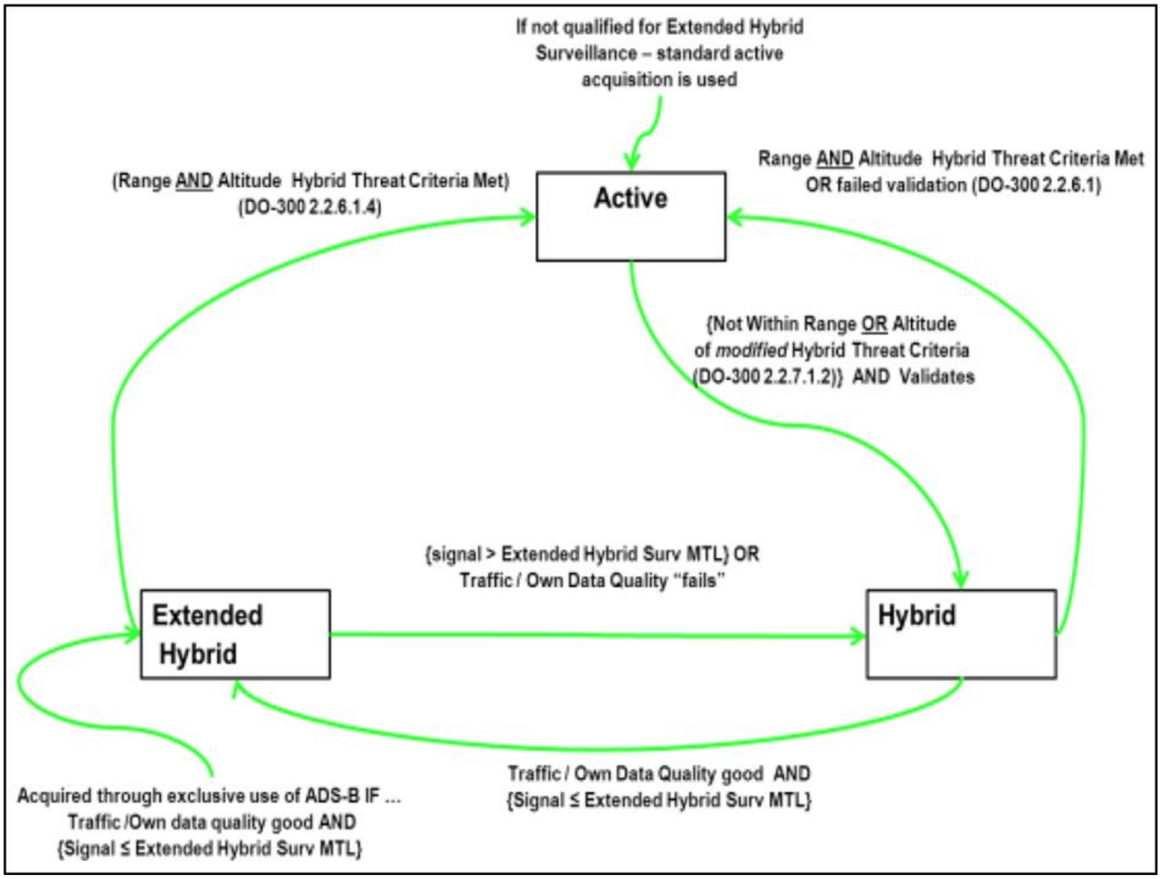


Figure 3. Extended Hybrid Surveillance State Transition Diagram (Ownship).

For an intruder to qualify as a hybrid surveillance target, the Mode S transponder data must pass the following validation test:

|slant range difference| ≤ 290 meters; and

|bearing difference| ≤ 45 degrees; and

|altitude difference| ≤ 100 feet.

For an intruder to qualify as an extended hybrid surveillance target, the Mode S intruder needs to meet the following conditions:

a) ADS-B Version Number ≥ 2
b) Reported NIC ≥ 6 (<0.6 NM)
c) Reported NACp ≥ 7 (<0.1 NM)
d) Reported SIL = 3
e) Reported SDA = 2 or 3
f) Barometric altitude is valid

Ownship position source must the following data quality standards:

a) Ownship horizontal position uncertainty (95%) is < 0.1 NM
b) Ownship horizontal integrity bounds is < 0.6 NM with integrity of 1e^(-7)

An extended track will be established with the following conditions are met:

a) Two valid airborne position messages have been received within 5 surveillance update intervals.
b) The altitude in the two airborne position messages are within 500 ft of each other or are within a window large enough to accommodate a 10,000 fpm altitude rate – whichever is greater.
c) The Q-bit values in the two airborne position messages are identical.
d) The ICAO aircraft address is the same in both airborne position messages and the address is valid (not all zeroes or all ones).

A hybrid target enters the active surveillance region if both the range and altitude threat criteria are met or if it fails the validation test. In this region, the target is interrogated every second. An intruder track will transition to active surveillance if the following conditions are all true:

1) $-(s - 4500\ \text{ft})/\min(-1\text{ft/sec}, \dot{s}) \leq 60\ \text{sec}$

2) $-(r - 3\text{NM})/\min(-6\text{kt}/3600, \dot{r}) \leq 60\ \text{sec}$

3) Own aircraft is taking off or airborne per section 2.2.8

where:

$s = |\text{own altitude} - \text{track altitude}| = \text{altitude separation}$, in ft

$\dot{s} = (\text{own altitude rate} - \text{track altitude rate})\,\text{sign}(\text{own altitude} - \text{track altitude})$;

$=$ rate of change of s, in ft/s, with negative values indicating decreasing separation ;

$r =$ track slant range, in NM;

$\dot{r} =$ rate of change of r in NM/s, with negative values indicating decreasing range;

$\text{sign}(x) = 1$ if $x \geq 0$; -1 if $x < 0$.

Conditions 1) and 2) are referred to as the hybrid threat criteria.

As shown in Figure 4, the TCAS interrogation on the intruder track varies as a function of the collision potential.

Active Surveillance: TCAS active interrogation every 1s.

Hybrid Surveillance: TCAS active interrogation every 10-60s.

Extended Hybrid Surveillance: No TCAS interrogation.

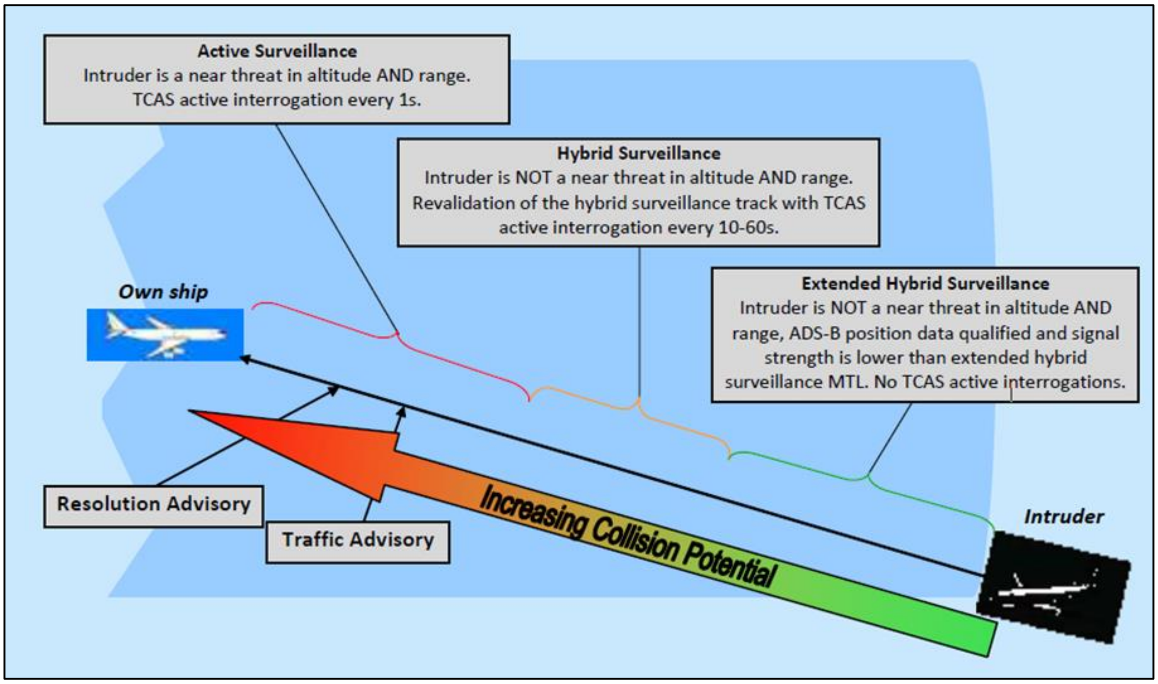


Figure 4. Transition from Passive to Active Surveillance as a Function of Collision Potential (ref. DO-300A).

2.2.5 Items not in Scope for FT4

● FT4 will not include Human System Integration (HSI) test points and will therefore not include any full mission flight profiles.

● No lighter than Air or rotor wing aircraft will participate in FT4.

2.3 Goals and Objectives

2.3.1 Flight Test 4 Objectives

The UAS-NAS Project worked with researchers, project engineers, and industry partners in conjunction with the RTCA SC-228 Working Group to capture and develop high-level overarching goals and objectives for FT4. Figure 5 provides the general top-level goals and objectives.

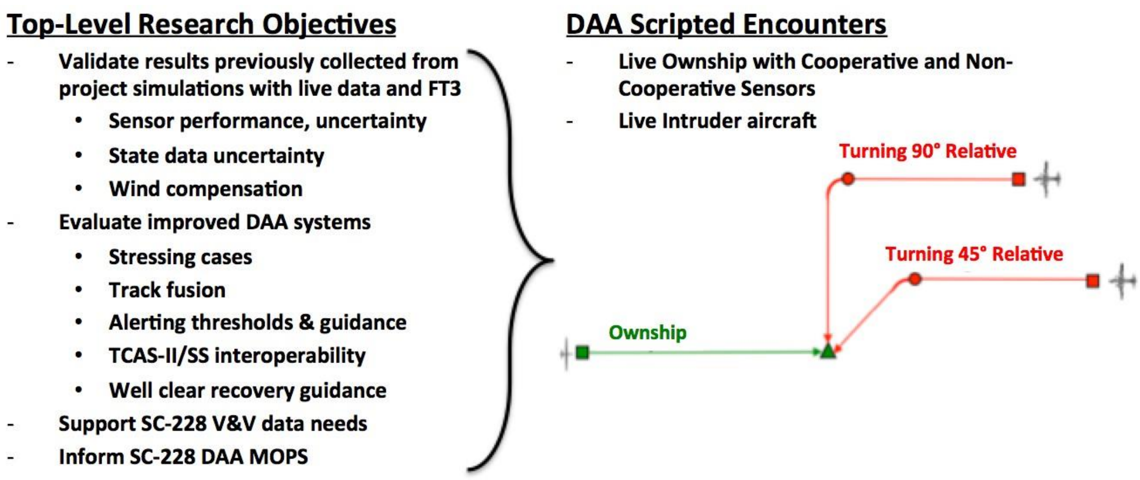


Figure 5. DAA Scripted Encounters Top-Level Objectives.

These top-level goals and objectives were transformed into high-level requirements and are covered by the Objectives and Requirements Document (ORD). Lower-level requirements resulting from decomposition of the ORD requirements are captured in the FT4 Flight Test Requirements Document (FTRD), System Requirements Documents (SRDs), and Interface Control Documents (ICDs).

Data collected from the FT4 flight tests will be analyzed and evaluated with the results applied toward supporting SC-228 in the MOPS development for civil UAS DAA Systems to pave the way for UAS integration into the NAS.

3 Flight Test Systems and Architecture

3.1 Flight Test Management

3.1.1 Success Criteria

The key to success is to ensure that the test aircraft are able to meet their spatial, temporal, and separation goals in order to provide the researchers with the data required for their evaluation of the DAA SUTs. Put another way, it is very important for the test aircraft to meet the timing and positioning objectives of the initial starting waypoints (i.e., IPs) and encounter points at the CPAs, achieving the desired angles of convergence, latitudes, longitudes, speeds, heading trajectories, turn and/or climb rates, and maintaining safe separation distances to induce the alerting and maneuver data sought.

To that end, the UAS DAA System alerts are expected to be provided to the PIC in a timely manner once an intruder aircraft breaches the CPA SS thresholds. If the DAA SUTs operate as anticipated, then the alerting is expected to allow for sufficient pilot response time to promptly evaluate options and perform the necessary maneuvers until WC is established and the DAA alerts are removed.

The following criteria is anticipated to be met for FT4 to be declared successful:

- Demonstrate the capabilities of the IT&E flight test infrastructure to conduct complex multi-intruder UAS DAA flight testing safely and efficiently
- Perform scripted encounters that trigger DAA alerting and maneuver guidance and interoperate with TCAS
- Collect accurate data to inform V&V of the Minimum Operational Performance Standards (MOPS) for Detect and Avoid systems

In summary, if FT4 is able to properly test the specific DAA functions of the SUTs in all of the various encounter scenarios and situations, then FT4 can be declared successful.

3.1.2 Vehicle Configurations

3.1.2.1 Ikhana Predator B (Ownship)

- Honeywell Tracking Software
- Non-Cooperative Sensor System (GA-ASI Air-To-Air Radar)
- Ground Control Stations (GCS) and Support Crew
- GCS Displays and Architectures
- GCS Software to accommodate TCAS II
- Conflict Prediction and Display System (CPDS)
- SSI JADEM (Incorporated into VSCS Display)
- SSI DAIDLUS Display
- Vigilant Spirit Control Station (VSCS)
- Avionics Packages for TCAS II, ADS-B, Mode C and Mode S Transponder
- Data Recording Equipment
- DGPS Recording System

3.1.2.2 Intruder Aircraft

- Avionics Packages for TCAS II (as required), ADS-B, and Mode C or S Transponders
- Honeywell N3GC is equipped with a TCAS II data recording capability. No other intruder is TCAS II recording capable.
- Navigation system that use Global Positioning System (GPS) derived position.
- Differential GPS (DGPS) or WAAS position truth source

3.1.3 Flight Test Systems Roles and Responsibilities

This section describes the roles and responsibilities for test systems provided by the various participating organizations participating in Flight Test 4. Flight systems include: aircraft, aircraft support systems (i.e. GCS), communication, IT, simulation, networking, and other systems and subject matters experts to support these systems that contribute directly to executing flight operations.

3.1.3.1 NASA Armstrong Flight Research Center (AFRC)

NASA AFRC is the responsible test organization for all test missions flown from AFRC. AFRC is responsible for hosting and supporting the LVC infrastructure for hosting data distribution between NASA Ames and Langley. AFRC is also responsible for providing the live unmanned aircraft to be used during the flight test encounters. The Predator B Ikhana UAS (NASA870) will provide the unmanned aircraft ownship platform to support flight test encounters within special use airspace. In addition to providing the UAS ownship aircraft, AFRC will also provide intruder aircraft (e.g., T-34, King Air).

3.1.3.2 NASA Ames Research Center (ARC)

NASA ARC is responsible for providing the one of the DAA systems (JADEM) to be used during DAA Scripted Encounters flight test. ARC is responsible for the development and testing of the LVC infrastructure, as well as the integration of the DAA software with the various hardware and software systems used during flight test. The LVC Gateway enables data distribution among all of the other NASA centers involved in the project, as well as to remote users through the Remote User Monitoring System (RUMS). Furthermore a researcher from SSI-ARC will help provide real-time encounter acceptability decision making during JADEM test runs.

3.1.3.3 NASA Langley Research Center (LaRC)

NASA LaRC is responsible for providing a DAA system (DAIDALUS) that will be displayed and evaluated during FT4 flight test encounters. Furthermore a researcher from SSI-LaRC will help provide real-time encounter acceptability decision making during DAIDALUS test runs.

3.1.3.4 General Atomics Aeronautical Systems Inc. (GA-ASI)

GA-ASI is responsible for providing hardware, software and integration support on the NASA Predator B Ikhana UAS. GA-ASI will provide flight test encounter requirements for autonomous aircraft response maneuvers. GA-ASI's CPDS will be used to gather data for FT4 flight tests.

3.1.3.5 Honeywell (HW)

HW is providing the software for the Surveillance Tracking Module (STM) prototype that contains the Honeywell Fusion Tracker. Honeywell will also provide a Traffic Alert and Collision Avoidance System (TCAS) II equipped aircraft to support scripted flight test encounters by performing as the primary intruder. The HW aircraft is a C-90, King Air, capable of onboard TCAS data recording.

3.1.3.6 SC-228

The requirements subcommittee is a unique stakeholder because they are not providing hardware or software to FT4. Rather, they are providing overarching guidance and other inputs that will help IT&E create flight test program that better helps them evaluate the MOPS. Their test inputs will complement the other systems and collect information that other stakeholders did not plan to acquire but is of cross organizational interest.

3.1.4 Flight Test Planning

AFRC IT&E Subproject is responsible for developing the flight test plan for FT4. Support from ARC, LaRC, HW and GA-ASI is required in order to develop a comprehensive test plan. The baseline for the plan is DAA Scripted encounters conducted within the R-2508/2515 airspace complex located at Edwards AFB, CA.

3.2 Flight Test Resources

3.2.1 Live Resources

The flight test will require various mixtures of manned and unmanned aircraft types with different subsystem requirements (Table 1). The following aircraft are planned to be available for use in the flight test:

Aircraft	**Provider**	**Role**
Predator B “Ikhana”	NASA AFRC	UAS/Ownship
King Air (N3GC)	Honeywell	Primary TCAS II Threat/Intruder
T-34C (NASA865)	NASA AFRC	Second/Backup Low/Medium Speed Intruder
King Air (NASA801)	NASA AFRC	Second/Backup Medium Speed Intruder
GIII (NASA808)	NASA AFRC	Primary High Speed Intruder
TG-14 (NASA856)	NASA AFRC	Primary Low Speed Intruder
King Air C-12	USAF	Mode C Only Intruder (Medium Speed)

Table 1. FT4 Aircraft Equipment Requirements.

Aircraft	Role	EDM DRR	ADS-B	DGPS	TCAS-II	TCAS-I	Mode S	Mode C
	**Ownship** NASA AFRC Ikhana UAS	✓	✓	✓	✓		✓	✓
	**Primary Intruder** Honeywell Beechcraft King Air C90		✓	✓	✓		✓	
	**Secondary Intruder** NASA AFRC T-34		✓	✓		✓	✓	
	**Secondary Intruder** NASA AFRC King Air		✓	✓		✓	✓	
	**High Speed / Secondary Intruder** NASA AFRC GIII		✓	✓	✓		✓	
	**Low Speed / Secondary Intruder** NASA AFRC TG-14		✓	✓			✓	✓
	**Secondary Intruder** USAF C-12 (Mode C Only)			✓				✓

3.2.1.1 Unmanned Aircraft (Ownship)

An ‘ownship’ is the unmanned aircraft that hosts the systems (hardware and software) under test for FT4. Reference Flight Test Requirements Document (UAS-NAS.ITE.FT4.FTRD.REQ.20160127.R1) for detailed information.

3.2.1.1.1 Ikhana Predator B (NASA 870)

The NASA AFRC Predator B (Ikhana) is a turbo-prop single engine unmanned aircraft built by GA-ASI (Figure 6). Ikhana has been configured with the GA-ASI prototype Sense and Avoid (SAA) system that includes integrated hardware and software components enabling the aircraft to perform pilot enabled and autonomous response to collision conflict resolution. The system is dependent upon SAA sensors. The SAA cooperative sensors in the aircraft include an Automatic Dependent Surveillance-Broadcast (ADS-B) In/Out compatible Identification Friend-or-Foe (IFF), and a Traffic Alert and Collision Avoidance System (TCAS II). An Active Electronically Scanned Array (AESA) Air-To-Air Radar (ATAR) is installed to detect all airborne targets.

General Performance Characteristics

Weight:	10,500 lb
Speed:	200 kt
Ceiling:	40,000 ft
Endurance:	24 hr

Figure 6. FT3 NASA AFRC, Ikhana, T/N NASA 870, Ownship Aircraft.

3.2.1.2 Manned Aircraft (Intruder)

An ‘intruder’ is an aircraft that supports the flight test to permit the live data collection requirements to be met. Intruder aircraft must be properly equipped to support the flight test. Reference Flight Test Requirements Document (UAS-NAS.ITE.FT4.FTRD.REQ.20160127.R1) for detailed information.

3.2.1.1.2 Beechcraft C90 (N3GC)

The Honeywell Beechcraft C90 (Figure 7) is a twin engine turbo-prop, eight seat aircraft modified with an onboard TCAS system recording. The C90 will support the test mission as the primary ADS-B and TCAS II equipped intruder aircraft.

General Performance Characteristics

Weight: 9,650 lb
Speed: 247 kt
Ceiling: 30,000 ft
Endurance: 4.5 hr

Figure 7. Honeywell, Beechcraft C90, T/N N3GC, Intruder Aircraft.

3.2.1.1.3 T-34C Mentor (NASA865)

The NASA AFRC T-34C Mentor (Figure 8) is a turbo-prop single engine aircraft that seats two pilots in tandem. The T-34C will support the test mission as an ADS-B and TCAS I equipped intruder aircraft. NASA865 is also equipped with an Ashtech Z-12 DGPS system.

General Performance Characteristics

Weight: 4,300 lb
Speed: 214 kt
Ceiling: 25,000 ft
Endurance: 4 hr

Figure 8. NASA AFRC, T-34C Mentor, T/N NASA865, Intruder Aircraft.

3.2.1.1.4 Beechcraft B200 (NASA801)

The NASA AFRC Beechcraft B200 (Figure 9) is a twin engine turbo-prop aircraft. NASA801 will support the test mission as an ADS-B and TCAS I equipped intruder aircraft. NASA801 is also equipped with a Novatel ProPak6 DGPS system.

General Performance Characteristics

Weight: 12,500 lb
Speed: 292 kt
Ceiling: 35,000 ft
Endurance: 4.5 hr

Figure 9. NASA AFRC, Beechcraft B200, T/N NASA801, Intruder Aircraft.

3.2.1.1.5 Gulfstream GIII (NASA808)

The NASA AFRC Gulfstream III (GIII) (Figure 10) is a twin engine turbojet aircraft. NASA808 will support the test mission as the primary high speed, ADS-B and TCAS II equipped intruder aircraft. NASA808 is also equipped with a Novatel ProPak6 DGPS system.

General Performance Characteristics

Weight: 69,700 lb
Speed: 340 kt
Ceiling: 45,000 ft
Endurance: 5.5 hr

Figure 10. NASA AFRC, Gulfstream III, T/N NASA808, Intruder Aircraft.

3.2.1.1.6. Ximango TG-14 (NASA856)

The NASA AFRC Ximango AMT 200S (TG-14) (Figure 11) is a single engine motorglider aircraft. NASA856 will support the test mission as the primary low speed, ADS-B equipped intruder aircraft. NASA856 is also equipped with an Ashtech Z-Extreme DGPS system.

General Performance Characteristics

Weight: 1,874 lb
Speed: 132 kt
Ceiling: 10,000 ft
Endurance: 3.5 hr

Figure 11. NASA AFRC, Ximango TG-14, T/N NASA856, Intruder Aircraft.

3.2.1.1.7. Beechcraft C-12

The USAF Beechcraft C-12 (Figure 12) is a twin-engine turboprop aircraft. The C-12 will support the test mission as the Mode C only equipped intruder aircraft. The C-12 will be equipped with a Stratus 2S DGPS system.

General Performance Characteristics

Weight: 12,500 lb
Speed: 290 kt
Ceiling: 35,000 ft
Endurance: 4.5 hr

Figure 12. USAF, Beechcraft C-12 Huron, T/N TBD, Intruder Aircraft.

3.2.2 Virtual Resources

Although there are many core stakeholders contributing to the encounters, there are only three primary displays that the DAA alerting and situational awareness is displayed. JADEM uses VSCS. DAIDALUS uses an internally developed SA product and GA uses CPDS. TCAS alerts appear on both VSCS as well as the GCS HUD.

3.2.2.1 Vigilant Spirit Control Station (VSCS)

The Vigilant Spirit Control Station was originally developed by the Air Force Research Laboratory (AFRL) as an integrated ground control station for command and control of single or multiple UAS. VSCS Tactical Situation Display (TSD) was augmented by AFRL with self-separation display elements based on inputs from the NASA Human Systems Integration (HSI) group. The VS traffic display and Java Architecture for DAA Extensibility and Modeling (JADEM) algorithm provide the pilot with three general categories of information intended to support: 1) situation awareness, 2) DAA alerts for potential losses of well clear, and 3) DAA maneuver guidance (OmniBands, well clear recovery, and TCAS-II interoperability). Figure 13 shows an example of the evolution of an encounter as it progresses from a preventive intruder through a collision threat. This progression of alerts highlights important features, including DAA icon symbology, heading bands with various levels of alerting, well clear recovery guidance, and TCAS RA. The full set of alerts symbology can be found in Appendix E.

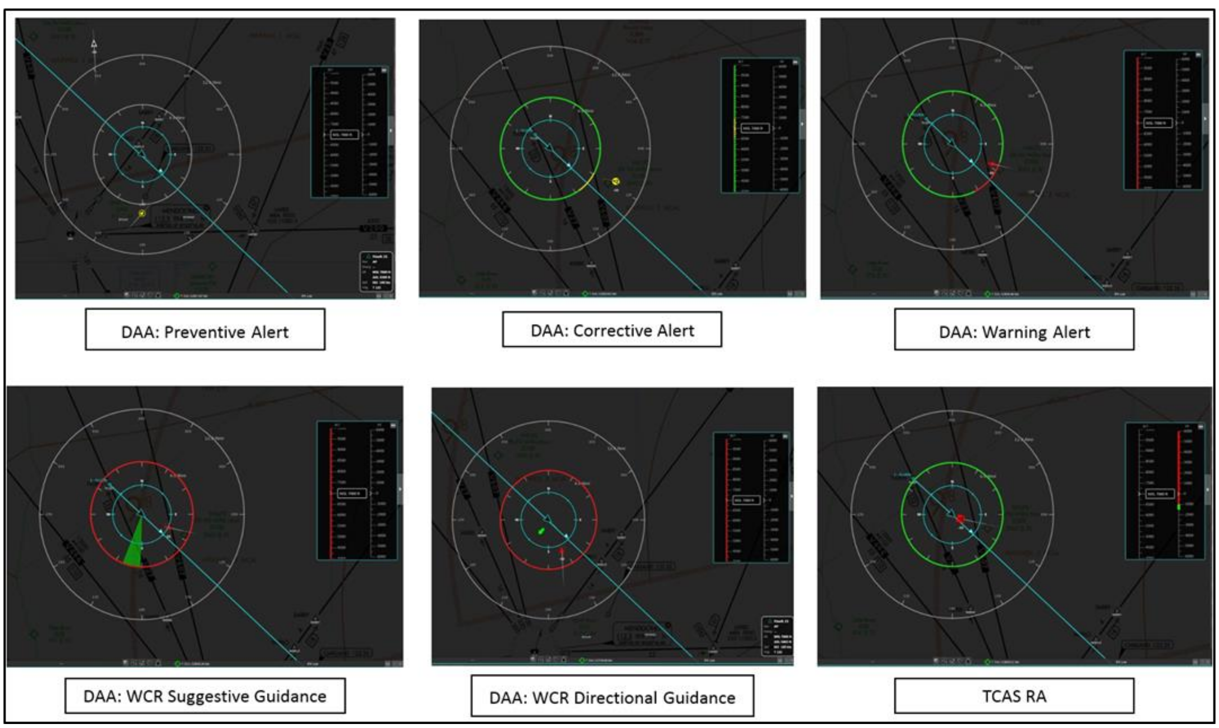


Figure 13. Vigilant Spirit Control System (VSCS) with JADEM.

3.2.2.2 Detect & AvoID Alerting Logic for Unmanned Systems (DAIDALUS)

DAIDALUS is a stand-alone display developed internally at LaRC. Their display (Figure 14) is similar to the VSCS display that SSI-Ames uses. DAIDALUS subscribes to LVC flight state messages to receive ownship and surveillance data.

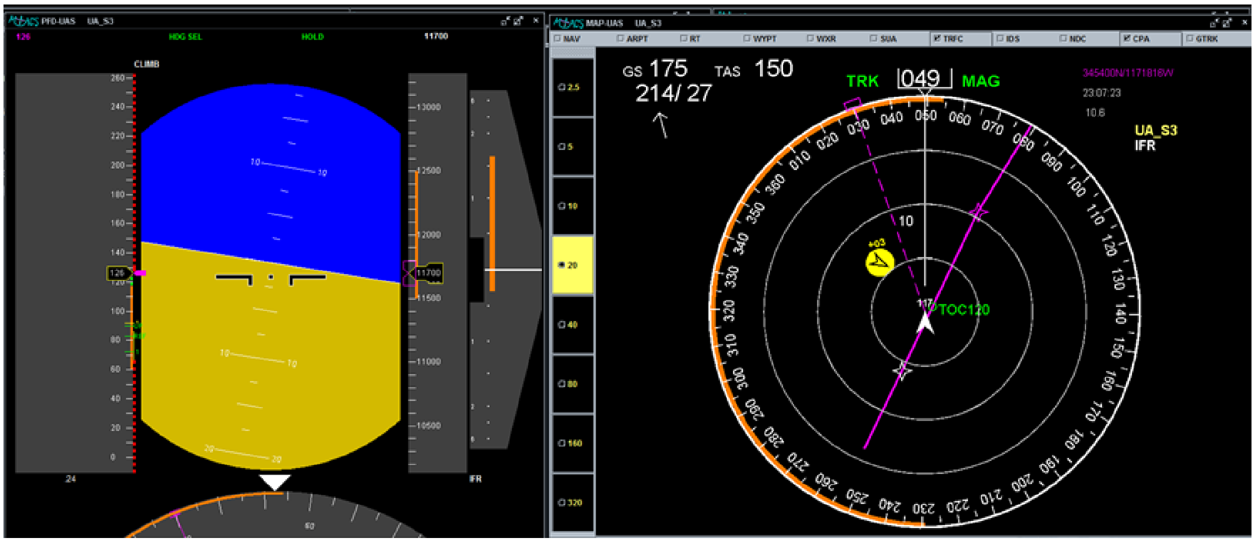


Figure 14. SSI-Langley DAIDALUS Screen Capture.

3.2.2.3 Conflict Prediction and Display System (CPDS)

Figure 15 shows a screen shot of the Conflict Prediction and Display System (CPDS) developed by General Atomics, which provides GCS-TD functionality. It shows the ownship aircraft with proximal surrounding traffic. During the FT3 the CPDS will provide the UAS pilot with situation awareness and SS advisories.

A key feature of the CPDS is to keep the pilot involved in conflict resolution before collision avoidance is necessary. The CPDS is a display that helps the pilot obtain sufficient situational awareness to anticipate and resolve potential conflicts before they become time-critical through the implementation of Conflict Probes [6].

Figure 15. GA-ASI Conflict Prediction and Display System (CPDS).

3.2.3 Communications Resources

DAA Scripted encounter communications are virtually identical to the plan used during the ACAS Xu and FT3 flight test missions (Figure 16). All participating test aircraft will communicate on mission net in order to execute the flight test encounters. SPORT will also participate on this net and provide real-time aircraft deconfliction advisories and airspace boundary calls, as required. The TC will control the flight test on mission frequency and negotiate with SPORT for airspace boundary requirements, such as requesting Buckhorn MOA and other airspace requirements.

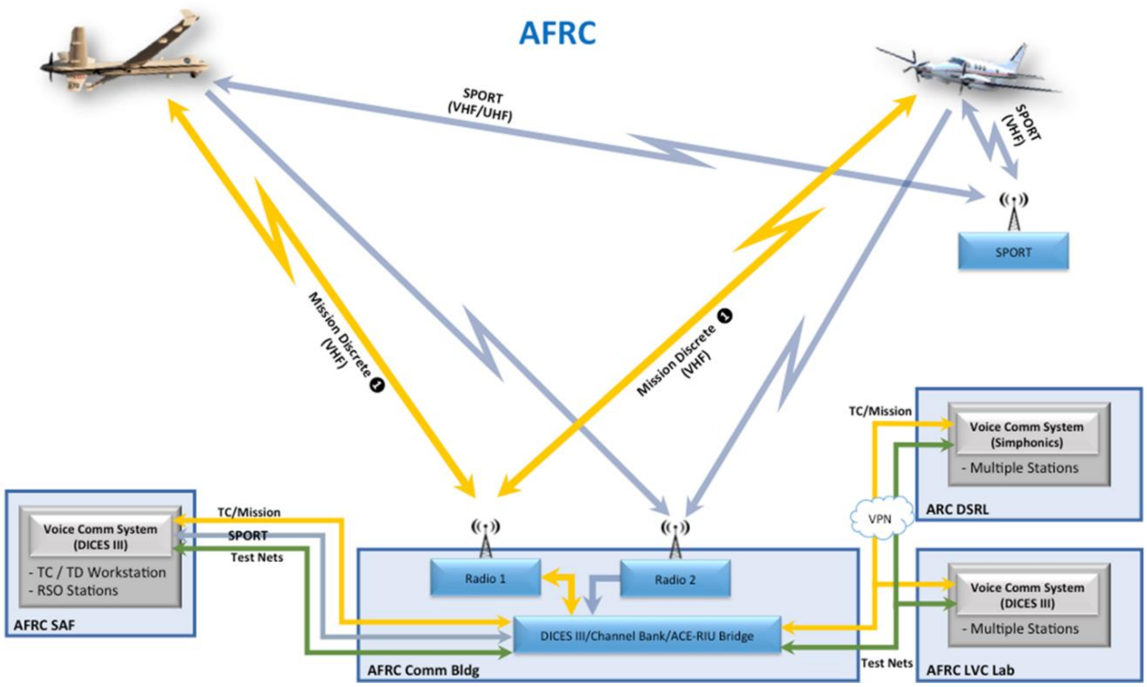


Figure 16. FT4 Voice Comm Architecture at AFRC.

3.2.4 Test Support Resources

The test is planned to be performed within the R-2508 range complex which provides for the use of several organic test support resources to include:

3.2.4.1 Test Facilities

Table 2 presents a list of the test facilities to be used for FT4 and their purpose. Testing will be conducted at three primary facilities: the DSRL and CVSRF labs at NASA Ames and the RAIF lab at NASA Armstrong. The DSRL lab at NASA Ames will be the virtual control center as well as contain the core LVC interface components, including HLA, HLA Toolboxes and the LVC Gateways. CVSRF is also located at NASA Ames and will run the instances of MACS ERAM and MACS SimMgr. The RAIF at NASA Armstrong contains two work areas, the RGCS/UAV Simulation Development Lab and the LVC Distributed Environment Lab. The first contains the RGCS, which connects to the HLA via an LVC Gateway. The second contains the LVC Gateway and simulation monitoring displays. The LVC lab also serves as a viewing area for project VIPs. For FT4 test execution, the RGCS will not be used. The SAF provides the test execution location for test conductor, test director, and other required personnel. The situational awareness displays: Zeus and QuickLook 2 are located in the SAF and provide the ability to create and test geometry templates used to track test aircraft during actual flight test missions.

Table 2. List of FT4 Facilities.

Facility	Location	Component
Crew Vehicle Simulation Research Facility (CVSRF)	NASA Ames	MACS ERAM, MACS SimMgr
Distributed System Research Laboratory (DSRL)	NASA Ames	HLA
Research Aircraft Integration Facility (RAIF) UAV SIM Development Lab	NASA Armstrong	RGCS, LVC Test Support
Stand Alone Facility (SAF)	NASA Armstrong	SAF, Zeus, QuickLook 2

3.2.4.2 Dryden Aeronautical Test Range

The Dryden Aeronautical Test Range (DATR) supports the actual flight test environment with telemetry, communication and data processing systems.

- DATR telemetry tracking systems consist of multiple fixed antennas at Armstrong and a fleet of mobile systems for deployment to specified locations. The antennas are capable of supporting down-linked telemetry and video signals in C-, L-, and S-bands while sending up-linked commands in either L- or S-bands. The antennas track targets from horizon to horizon and are certified as having full on-orbit capability for low earth orbiting spacecraft. Down-linked telemetry may be received in either analog or digital format. Mobile operations can provide telemetry tracking for test missions operating outside local airspace boundaries.

- The Radio Frequency (RF) Communications facility provides more than 40 ultra-high frequency (UHF), very high frequency (VHF), and high frequency (HF) transmitter receivers, and a UHF flight termination system (FTS). An extensive range intercommunication system consists of trunk lines, communication panels, public address systems, commercial telephone systems, and military ground communication networks. An integrated network of communication, fiber optic, and satellite systems is also used to relay telemetry, radar, audio, and video data between Armstrong facilities, NASA centers, other government agencies, and industry partners.

3.2.4.3 Edwards Air Force Base

Edwards Air Force Base (EAFB) provides a host of test support resources for the flight test environment including main base runways (Rwy 04L/22R & 04R/22L), Class D control tower services, weather briefings, airspace/airfield management offices, restricted airspace scheduling, and other airport support services (Figure 17).

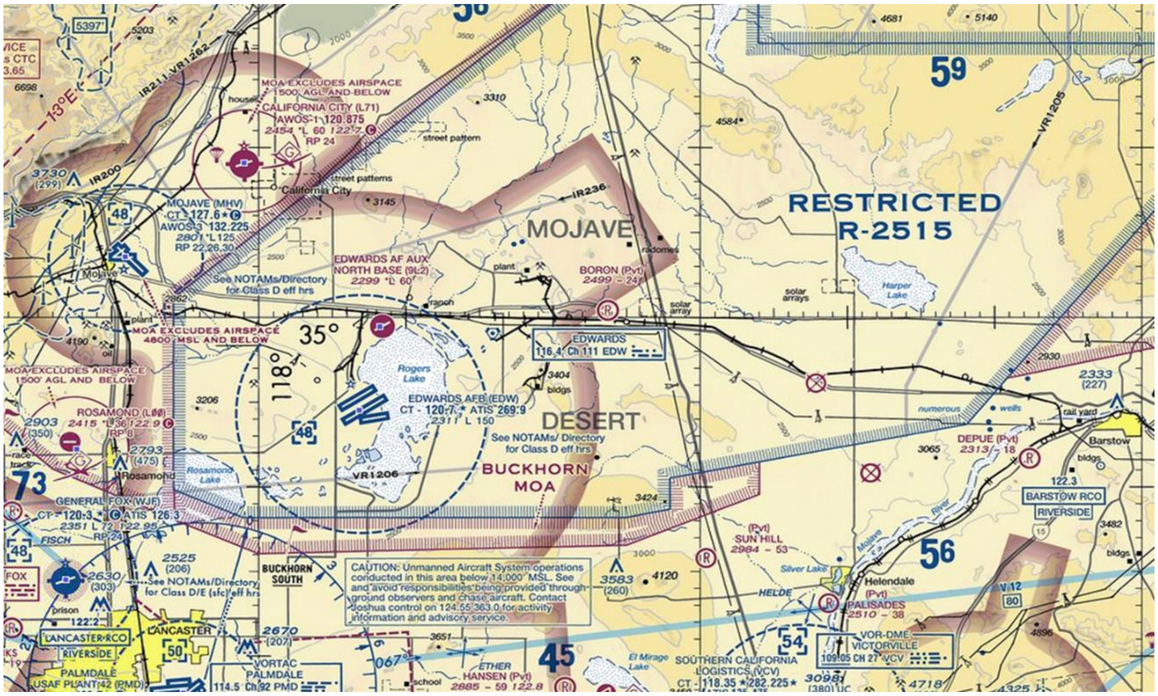


Figure 17. Edwards Air Force Base Class D & R-2515 Airspace.

3.2.4.4 Flight Test Environment

The test environment for performing DAA Scripted encounters requires sterile airspace to perform the encounters with 1,000 ft vertical buffers below the lowest participating aircraft and 1,000 ft above the highest participating aircraft. These encounters will be flown within the R-2515 in scheduled airspace that omits other users during the period scheduled. Due to limitations to the size of the scheduled airspace, at times intruder aircraft may maneuver outside of the assigned airspace with concurrence by the dedicated SPORT controller.

3.2.4.5 Operating Area

The operating area for FT4 is identical to FT3 and planned for the Restricted Airspace, R-2515 along with the Buckhorn Military Operating Area (MOA), with operations scheduled and coordinated through the Air Force Test Center (AFTC). Specific airspace scheduled each day during these flight tests included the Four Corners Area, Mercury Spin Area, overflight of the Precision Impact Range Area (PIRA) East/West, and the Buckhorn MOA. These areas within R-2515 are depicted within the yellow shaded area shown in Figure 18. Flight Test Area. These areas may be extended within R-2515 if available and authorized by SPORT.

In some encounter circumstances extensions north and west of the yellow shaded area may be required. The extensions are necessary to either start or complete these encounters and accommodate for geometry or aircraft performance limitations, e.g. NASA808. Approval from the controlling agency (SPORT) will be required. The Buckhorn MOA will be used by the manned intruder aircraft only.

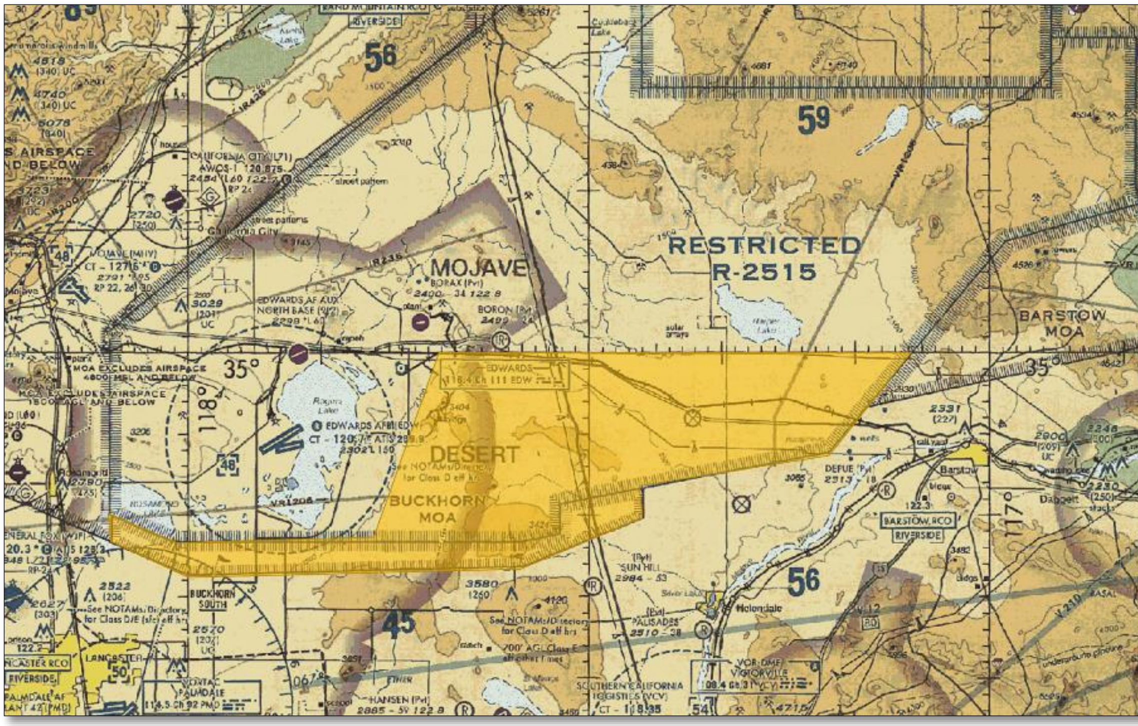


Figure 18. Flight Test Area.

3.2.5 Instrumentation and Data Collection Resources

3.2.5.1 High Level Architecture (HLA) and LVC Gateway

The framework for the simulation environment will be supplied by the LVC via the High Level Architecture (HLA) messaging infrastructure. The LVC uses a version of the IEEE 1516 standard Pitch portable Real Time Infrastructure HLA and Federation Object Model (FOM) middleware, modified at NASA Ames, to exchange information about the air traffic environment (aircraft state, flight plans, digital messaging) among the participants operating from distributed facilities. The HLA utilizes Toolboxes to convert data from simulation components (e.g. flight simulator, or air traffic control display) into its expected format. The LVC Gateway (Figure 19) was developed to enable passing of messages within a facility (without the need to distribute them to HLA), for those messages that are then required to be sent to a distributed facility, the gateway connects to HLA via a toolbox.

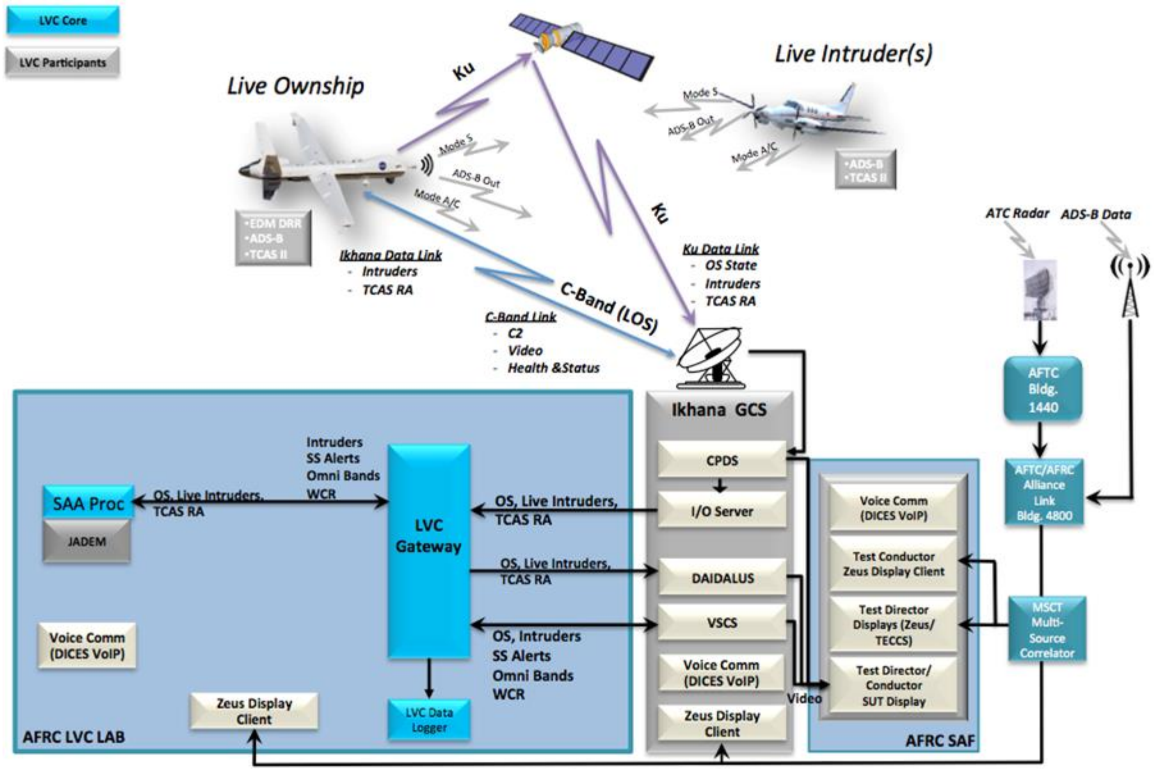


Figure 19. FT4 Resource Architecture at AFRC.

3.2.5.2 Remote User Monitoring System (RUMS)

In order to facilitate the monitoring of the data collection, the Remote User Monitoring System (RUMS) software processes connects to the LVC Gateway process and provides an ability to access and display data being collected via a web browser. The RUMS server connects to the LVC Gateway and handles the web browser data requests.

3.2.5.3 ADS-B Receiver Data Source

A Thales AX680 dual-channel (Mode S 1030 MHz and 1090 MHz) receiver is located in NASA AFRC Building 4800 to provide near real time ADS-B data. The received signals are digitized by the Thales receiver, then securely disseminated live and unfiltered via Ethernet. The Thales receiver also tracks aircraft represented in the Mode S 1090 MHz Extended Squitter (1090ES, or ADS-B) messages and forwards the Thales tracker updates for those aircraft as well.

The 1030MHz and 1090MHz data are sent out as binary data. The Thales tracker data are disseminated as ASTERIX messages, with tracker surveillance updates sent as Category 21 messages and system configuration / status data sent as Category 23 messages. All three data streams (digitized 1030MHz, digitized 1090MHz, and ASTERIX tracker/status data) are securely disseminated live and unfiltered via Ethernet by the Dryden Aeronautical Test Range support office located at NASA AFRC.

The Thales data will be used to assess the validity of position data broadcast by ADS-B equipped aircraft in flight and determine whether the broadcast position data are of a quality to support of Flight Test 4. The data will also be used to drive a scenario development display and Zeus display that will provide situational awareness information to the Test Director (Figure 20. UAS-NAS Project Stand Alone Facility Work Station.).

All of the data types published by the Thales system are transmitted via Ethernet to a single multicast address, with each message type (1030MHz, 1090MHz, ASTERIX Category 21, and ASTERIX Category 23) identified by a separate port number. Data are time-tagged with UTC time and recorded on a daily basis with file rollover at midnight UTC. The aggregate size of the daily message files depend on traffic conditions, generally in the range of 150 MB to 200 MB per day, with most of the message traffic corresponding to periods of high levels of air traffic.

3.3 Flight Test Equipment

Aircraft Required Systems

All participating aircraft require the following minimum required equipment:

- ADS-B Out
- Mode 3/C or S Transponder
- GPS
- DGPS with recording
- VHF Voice Comm Radio (2)

One exception to the aforementioned requirements is the USAF 419th Test Wing C-12 aircraft that will support specific Mode C only flight test encounters required by the researchers. The C-12 will not be equipped with ADS-B in support of FT4.

In addition to the minimum required equipment, certain participating aircraft require specific equipment for flight test as described in 3.3.1.1-3.3.1.4:

3.3.1.1 Navigation Systems

Aircraft supporting this flight test are required to be equipped with navigation systems that use Global Positioning System (GPS) derived position. Due to strict timing and position requirements, aircraft shall not use any mode of navigation that does not use GPS as the primary source for navigation.

All aircraft will use as installed, certified altimeters with a standard QHN barometric pressure setting window. All tests will be performed using 29.92 hg altimeter setting once cleared into the test area by Edwards Tower or the SPORT controller.

3.3.1.2 Certified Systems

A manned intruder aircraft equipped with TCAS II change 7.1, for the purpose of demonstrating legacy TCAS interoperability, the reception of and compliance with 1030 MHz. Honeywell C90 (N3GC) is planned to support this requirement.

A TCAS traffic display or a similar type display installed on participating manned intruder aircraft, in addition to visual, will be the means by which those aircrew will maintain situational awareness for safety during the DAA Scripted flight test. The NASA AFRC intruder aircraft (T-34C or B-200) are equipped with TCAS I only. NASA808 (GIII) is equipped with TCAS II change 7.1 and serves as a TCAS II backup aircraft to N3GC. NASA856 (TG-14) is not equipped with TCAS. The USAF C-12 will be provided with a Stratus 2S system for SA purposes and TSPI data recording.

For the purpose of situational awareness on the ground, interoperability demonstration, and data collection, all aircraft will be equipped with ADS-B, except as noted.

For some encounters a Mode C only equipped intruder aircraft is required. This requirement can be supported with NASA856, but for higher airspeed encounters this requirement will be supported by an Air Force C-12 aircraft.

3.3.1.3 Prototype Systems

● Engineering Development Model (EDM) Due Regard Radar (Air-to-Air Radar):
EDM is a radar system which supports an airborne SAA architecture for the Predator B UAS. The EDM ATAR is an advanced prototype developmental radar system that has increased surveillance volume and is intended to be installed in the NASA AFRC Ikhana as part of a SAA system that senses both cooperative and non-cooperative aircraft, fuses the sensor data, generates alarms.

● Honeywell Tracker:
The Honeywell Tracker fuses all sensor data that is available for a given target. For cooperative targets, ADS-B, TCAS, and EDM measurements (when available) may be fused. For non-cooperative targets, only EDM measurements are available.

3.3.1.4 Truth Data Source System

All aircraft supporting FT4 testing shall have a Time Space Position Information (TISP) or dGPS-based truth data source. Moreover the TISP data source must have recording capability that can be collected post flight for archiving and distribution amongst the test team.

3.3.2 Software Systems

Table 3 describes the applications required to support FT4.

Table 3. FT4 LVC System Software.

Application	Description
AFRC	
Data Processor	Post-test processor for Data Collector data
AFRC ADRS	Server that allows external simulation interfaces to MACS

Application	Description
AFRC MACS	Multi Aircraft Control System Ground Control Station Alerting Display
ADRS (DAIDALUS)	Server that allows external simulation interfaces to MACS DAIDALUS
MACS (DAIDALUS)	Multi Aircraft Control System Ground Control Station Alerting Display
MACS (Stratway Moving Maps)	Multi Aircraft Control System Moving map display for DAIDALUS
Saa_Proc	Sense and avoid Process
VSCS Control Station	Vigilant Spirit Control Station
LVC Gateway	Server that allows external connections to the HLA
Gateway Data Logger & Data Player	Records flight state and flight plan messages received by the LVC Gateway – Plays back recorded data
Gateway Data Collector	Records ownship views, Aircraft and Intruder flight states, and archive LVC subject data, Data collector/recorder software
CPDS	General Atomics ASI Traffic Display, SS algorithm, UAS-GCS interface.
IOServer	Interface between CPDS and LVC Environment

3.3.3 Control Room Systems

Stand Alone Facility (SAF) – The SAF, located at NASA AFRC in building 4800, will be used by the test conductor and test director to coordinate, manage, and execute the flight test. The room has three workstations dedicated to UAS-NAS operations (Figure 20). Each work station is configured with DICES VOIP voice comm systems and several display monitors (e.g. ZEUS, Quick Look 2, Ikhana video camera sources, and DAA algorithm traffic displays) providing situational awareness and two-way voice capability to the control room team for test execution.

Figure 20. UAS-NAS Project Stand Alone Facility Work Station.

3.4 Security Requirements

Security policies and agreements will be established and followed as required by NASA and partner organizations.

3.4.1 General Security

The tests will involve and be conducted by NASA civil servants and contractors; specific partner agreements for external partners for these tests are in place and on file.

3.4.2 Operations Security

There is no sensitivity to the data collected during the tests, except for the radar data which is considered ITAR.

3.4.3 Communications Security

Voice communications will be conducted via actual RF radios transmitting in free space or with comm links over an encrypted VPN. All participants are diligent to potential comm radio spoofing/interference that sometimes occur on VHF nets.

3.4.4 IT Security

All transmissions between distributed facilities are encrypted. The specific IT security plans are on file and under access control.

3.4.5 Data Security

The Data Management Plan (IT&E DMP-01) contains the details regarding handling and storage of the data.

3.5 Flight Test Limitations

The following limitations apply to Flight Test 4:

- Some test encounters (unmitigated) will use actual offsets to test algorithm performance, however, a minimum horizontal offset of 0.4 nmi and a minimum vertical offset of 200 ft will be used in order to maintain safety of flight for all encounters with less than 500 ft vertical offset.
- The Engineering Development Model (EDM) Due Regard Radar has a field of regard limited to ±110° in the horizontal direction and ±15° in the vertical direction.
- As during FT3, some FT4 scenarios will require TCAS active coordination, the ownship or intruder aircraft may be expected to maneuver when an alert occurs during these encounters. At other times, the intruder will disregard TCAS alerts which will ensure that the ownship aircraft receives an alert and has an opportunity to act on it. This, however, does not preclude the TCAS equipped intruder aircraft from responding to TCAS alerts for non-participatory aircraft since these alerts would be unplanned and are to be considered a real-world safety of flight threats.
- TCAS Alerting will occur in two locations within the GCS: the HUD and the SUT display. When using JADEM or DAIDALUS's displays the TCAS alerts will appear on left side mounted SUT monitor. Additionally for CPDS, alerting will also be passed through the GCS system to the HUD. Although both JADEM and DAIDALUS are capable of Aural Alerts, only JADEM will use this feature. DAIDALUS stakeholders elected not to use this feature since it is not one of their objectives. Training will need to clearly articulate which system is "under test" at any given time and should be used to make test decisions. Safety decisions shall not be made using the SUT.
- The fastest aircraft available and compliant for FT4 is NASA808 but it cannot meet the speed of 600 KTAS desired by some of the researchers. However, the 600 KTAS is

a design specification and the short coming can be mitigated through modeling and simulation using relevant data collected by the GIII; therefore, 340 KTAS is the highest airspeed available for FT4.

4 Flight Test Execution

NASA Armstrong is the responsible test organization for FT4. The NASA Armstrong airworthiness and flight safety review process will apply to all encounters flown out of AFRC. This section identifies general and specific operational processes and procedures that will be used to execute the flight test.

Flight safety is essential to all test encounters and aircrew are expected to use good judgment at all times. Flight test encounters will be performed using a safety buildup approach which means that test cards with encounters that have the greatest vertical separation will normally occur first followed by encounters where the vertical separation is decreased. Once a particular test encounter geometry has been cleared at a specific vertical separation, like encounters performed on subsequent test days do not require a repeat of the test buildup task. This is also the case for multi-ship test encounters and complex geometries that include blunder (vertical or horizontal) maneuvers.

Visual identification (VID) with ownship aircraft is required by all intruder aircraft operating with a vertical separation of <500 ft and ≤1 nmi horizontal separation (2 nmi for high speed encounters) to ownship based off the onboard situational awareness display. Once VID is established with ownship aircraft, the intruder pilot will callout ‘visual’ on the TC/SPORT (Mission Discrete) net. Visual is required to be maintained while operating within the aforementioned criteria or an abort will be performed by all aircraft to increase separation. For multiship encounters, the VID applies to all manned aircraft operating within the minimum separation volume.

ATC (Joshua / SPORT) expects all participating aircraft to remain within the scheduled/assigned airspace boundaries at all times unless prior coordination/permission is provided by ATC deviate from the assigned airspace. Ikhana is prohibited from operating within a MOA or the NAS unless a specific COA exists permitting that operation.

Sections 4.1 through 4.5 describe procedures and tasks required for every test day unless otherwise noted. Sections 4.5 describe specific requirements, procedures, and tasks for DAA scripted encounters.

4.1 Mission Briefings

Flight test operations will typically be preceded by two briefings using the NASA Armstrong standard operating procedures.

4.1.1 Preflight Brief

The first prebrief is called a T-1 briefing which is normally performed the day prior to a mission. All flight test participants are required to participate in the T-1 briefing. The T-1 briefing covers numerous topics that include the following: Roll Call, Mission Summary (Overview & Objectives), Mission Timeline, Weather & NOTAMS, Aircraft/GCS/Airfield Status, Comm Data, Mission Information (Mission Rules, Go/No-Go, and Flight Safety), Test Overview & Procedures, Test Card Review.

Day of Flight brief (T-0) typically occurs a few hours prior to the flight and is a short 15-20 minute tag up briefing used to complete a time hack, discuss current weather, cover changes (if any), and generally to focus the team on the test.

4.1.2 Post-Flight Brief

The post flight debrief is used to review the mission in terms of timeline (i.e. what occurred), test results, aircraft squawks, lessons learned, issues, and future planning.

4.1.3 SUT Training

Prior to executing test a crew training brief will provide necessary information to the aircrew executing the test. The following as a minimum will be part of the training:

- Specific goals and objectives for the respective SUT
- Specific user interfaces; VSCS, DAIDALUS, CPDS and HUD symbologies.
- How the research team would like the aircrew to interpret and use the symbology. This includes the desired maneuver profile.

4.2 Standard Flight Test Procedures

Pilots will comply with all standard flight rules as described within applicable FARs (14 CFR) and local guidelines as appropriate. The standard requirement to 'see and avoid' other aircraft (14 CFR Part 91.113) applies. The exception is Ikhana when operating within special use airspace where other mitigations (i.e. mission rules, SOPs, etc.) apply in order to help ensure safe flight operations. Aircrew are expected to complete an R-2508 range briefing and a local area briefing prior to flying in the test range.

4.2.1 Air Traffic Control

All airborne participants shall comply with local ATC rules as they apply in the execution of the flight test encounters. Within the Edwards Complex (R-2515), Space Positioning Optical Radar Tracking (SPORT) MRU has ATC authority except during periods of time when operational control is assumed by FAA TRACON Joshua Approach Control.

4.2.2 Visual Flight Rules

All flight test encounters shall be performed using visual flight rules (VFR) as described in 14 CFR Part 91.151, 153, 155 and 159 as they apply to operations within Class E airspace, except where organizational guidelines (NPR, company FOM, for example) take precedence (if more restrictive). Operations within the R-2508 Complex must comply with guidance provided by the R-2508 Complex Users Handbook, EAFBI 13-100, and the aforementioned sections of 14 CFR Part 91. This does not preclude the use of Ikhana, which has procedural means for fulfilling these rules in Restricted Airspace.

4.2.3 Weather

Weather considerations are based on operating in Visual Meteorological Conditions (VMC) at all times during flight test encounters. VMC, or clear of clouds, requires aircrew to operate with outside of visible moisture. For FT4, the minimum weather conditions are defined as cloud ceilings at least 1,000 feet above or below the designated altitude block (as described on the test card) and visibility exceeding 3 statute miles are required. Any other potentially prohibiting flight conditions such as wind, turbulence, and/or precipitation that exceed established criteria for launch or recovery cancels or delays tests until conditions are within tolerance. Any other conditions that interfere with successful flight test outcomes are taken under consideration by the team. Before each scheduled flight, the test team confers via Telecon (during the day of flight brief) to make a final "go/no-go" decision based upon the current and forecast weather or any other last minute changes in operational restrictions.

4.2.4 Aircraft Calibration Procedures

All participating aircraft are expected to have a current altimeter calibration in accordance with airworthiness certification requirements for the type of FAA aircraft certificate held. Pilots are expected to perform a ground altimeter check prior to flight operations to determine whether the altimeter is within normal limits (±75 ft). All encounters flown in the Edward Complex shall use 29.92 altimeter setting as a standard. For flight test operations that are planned to be ≥500 ft vertical separation, no airborne altimeter calibration check is required; however, it is likely that during every flight test day an altimeter calibration will be performed prior to accomplishing any flight test encounters. An altimeter calibration check test card will be developed and provide to aircrew prior to performing altimeter calibration checks.

It is standard for the intruder aircraft to rendezvous with ownship (Ikhana) initiating the rejoin with 1,000 ft vertical separation and upon obtaining a visual with ownship rejoin to a wing position. The standard altimeter setting is 29.92. Once rejoined, the ownship will report altimeter setting and current altitude. Intruder aircraft will then report their altimeter setting and altitude. If the intruder reports a different altitude than ownship, the intruder will correct (adjust) their altimeter setting to match the altitude reported by ownship. Once the procedure is complete, each aircraft will again report altitude to verify a match. For multi-ship intruder missions, each intruder, in sequence, will perform an altimeter calibration with the ownship. Once the procedure is complete, intruder aircraft are expected to clear off the formation by descending at least 500 ft below Ikhana's current altitude and remaining well clear. For test expediency and/or due to intruder aircraft performance limitations, altitude calibrations may be performed off another intruder aircraft that has calibrated their altimeter off of Ikhana.

Low altitude radar flight test encounters (<10,000 ft MSL) will use 29.92 altimeter settings since those encounters have 1,000 ft vertical separation and the floor for all test encounters is 1,000 ft AGL above the highest terrestrial feature along the planned route of flight for those encounters. For test days where low pressure prevails, the team may redline the minimum test altitude to accommodate the 1,000 ft AGL floor minimum.

All participating aircraft shall monitor GPS navigation error reporting and inform the test conductor if the navigation system reports lateral errors greater than 0.1 nmi (608 ft). Aircrew will monitor the reported GPS position quality (figure of merit) prior to each test run to ensure that the reported error does not exceed test limits. No airborne navigation calibration checks are planned.

All participating aircrew will manage encounter timing using GPS time. A time hack based off the SAF IRIG clock will be performed prior to conducting flight test. Tolerances (timing/distance/performance) for a given encounter will be identified on the respective encounter test card and can be found on the specific flight test objective templates (see Appendix F).

4.2.5 Standard Test Procedures

All participating aircraft are expected to follow applicable test card instructions. Test cards are designed to have a common format with unique components according to the role (ownship or intruder), specific tasks (display under test, encounter maneuvering, multi-ship, etc.), and other guidance.

- Ownship will use normal piloting techniques and GCS tools to arrive at the test encounter IP on course and on time within the prescribed tolerances.
- Intruder aircraft will use normal piloting techniques and onboard tools to arrive at the test encounter IP on course and on time within the prescribed tolerances. It is standard for each intruder aircrew to record actual wind data (heading and velocity) at the IP for every test encounter performed. The pilot will be prepared to report the wind value on mission frequency, if requested. Intruder pilots will provide their recorded wind data to the TCOR post flight.
- Encounters are planned to occur approximately every 10 minutes. As the encounter complexity increases or as either ownship or intruder crews require, time between encounters can be increased. Participating crews should request a ‘rolex’ if they are unable to meet the COMEX time.
- Researcher and Engineering involvement will be increased from FT3 through the use of RUMS or other real time analysis tool. The engineering teams will coordinate through the Test Director as required to modify planned encounters as required.
- All lateral blunder maneuvers are planned for aircraft to perform standard rate turns except for high speed intruder aircraft where ½ standard rate turns are planned.

4.3 Flight Test Coordination

Successful flight test requires a team effort executing a flight test plan that meets test objectives in a safe and efficient manner.

4.3.1 Flight Test Roles and Responsibilities

The test team has several members who support the test and this section will describe the key roles and responsibilities for conducting the test.

Test Conductor (TC) – The Test Conductor has overall responsibility for test execution and mission success. The TC coordinates flight test scenarios with the aircrew to ensure that flight test objectives are met. The TC is collocated with and interfaces with the Test Director to maintain an overall picture of the test activity. The TC communicates directly via two-way radio with the participating aircrew and local ATC on a mission discrete channel. The TC workstation is located in the SAF.

Test Director (TD) – The Test Director has the overall responsibility for mission safety. The TD is collocated with and interfaces directly with the TC and coordinates with other test team members on back channel nets as required in order to feed the TC with information to help maintain an overall test picture. The TD interfaces with the NASA Senior Ops Representative (SOR) to ensure their understanding of flight test activities. The TD workstation is located in the SAF.

Test Coordinator (TCOR) – The Test Coordinator has primary responsibility for recording operational test data information obtained from data received within the SAF. The TCOR assists the TC in setting up follow-on test encounters and for configuring the SAF displays prior to the flight test.

Mission Director/Flight Test Engineer(s) – A Mission Director is assigned to each aircraft to help aircrew in the coordination and execution of the test scenarios and to ensure that mission rules are followed. For the unmanned aircraft, the Mission Director is located within the Ground Control Station and communicates with the aircrew to help in coordination and execution of test scenarios. A Flight Test Engineer (if available) flies in the jump-seat for manned aircraft and performs the role of Mission Director in assisting the aircrew in coordination and execution of test scenarios.

Aircrew – The aircrew consists of a pilot and a copilot. The aircrew flies test procedures outlined in this document adhering to navigation/timing constraints and abort procedures given for each flight test card. Aircrew also ensures that the aircraft stays within the vertical and lateral boundaries of the airspace that they have been cleared into. The aircrew coordinates test activities directly with the TC and local ATC to execute the test activity. Some intruder will also operate with a flight test engineer who will support in achieving successful test encounters.

4.4 Flight Test Safety

Flight safety is foremost to all flight test planning and essential to executing responsible flight operations. NASA Armstrong has flight safety responsibility for flight test operations performed at AFRC. Effective hazard analysis is the responsibility of all team members and are a required element to enabling the airworthiness and flight safety review board to make flight release decisions. Encounters that are separated vertically by 500 ft or greater are considered inherently safe based on the premise that standard acceptable

NAS operations allow for IFR and VFR traffic to operate within the same airspace with 500 ft vertical separation. See and avoid requirements always remain in effect regardless of what flight rules a given pilot is operating under.

4.4.1 Flight Safety Process

AFRC will lead the development of the hazard analysis and follow processes described in DCP-S-001 and DCP-S-002. All participants of FT4 are expected to support and contribute to the flight safety process for the flight test activities.

4.4.2 Planning Safety

Test encounters with a vertical separation of >500 ft do not require a lateral offset as this is considered “standard separation” for operations within the NAS (minimum vertical separation between IFR and VFR traffic in Class E airspace). Some mitigated encounters are planned for a 200 ft vertical and 0.4 nmi horizontal minimum separation which is the minimum separation allowed for FT4. These minima meet both the required levels of safety as well as technical requirements for the test.

4.4.3 Mission Rules

Mission rules are mandatory operational procedures specific to the planned flight test and are designed to support safe flight operations. These rules apply to every flight unless specific exceptions are identified within a given rule. Mission rules typically cover standard weather limitations, mission specific constraints to ensure flight safety, and other pertinent operational procedures not covered by the flight manual or other established guidance. FT4 final mission rules will be briefed and approved during the Tech Brief.

4.4.4 Go / No-Go

A Go /No-Go list is a mandatory set of decision guidelines used to determine whether a mission can be accomplished if required equipment, systems, or personnel are functional, operational and/or available and ready for the intended flight activity. FT4 final Go / No-Go will be briefed and approved during the Tech Brief.

4.4.5 Abort Procedures

Abort procedures are specific to each scenario flown and are annotated on the flight test cards. An abort is announced over the radio and all test participants must acknowledge including the TC.

Specific conditions which require an abort are outlined in the mission rules, but general guidance is that an abort is mandatory for the following circumstances:

- Unmanned aircraft goes Lost Link, or loses LOS Link (reverts to SATCOM)
- Timing constraints cannot be met within an acceptable tolerance as identified on flight test card
- “No Visual” after a specified distance between ownship and intruder aircraft (For FT4 this horizontal distance is 1 nmi when separated vertically by <500 ft)

- An aircraft begins a maneuver in unplanned vertical direction during an encounter
- When test participant observes an aircraft is in the wrong position or profile (executing the wrong test card)
- Judgment determines that the run cannot be continued safely

The general procedures for an abort are as follows:

1. Ownship Abort Procedure:

   Shall comply with procedures specified on the flight test card.

2. Intruder Abort Procedure:

   If the intruder aircrew has a visual on the ownship aircraft then the intruder aircraft can maneuver to remain well clear; otherwise, the intruder shall initiate a turn away from ownship and begin a vertical maneuver to increase separation as specified on the flight test card.

   If the intruder pilot has a corrective TCAS RA advisory before or during an abort, the pilot will follow the abort procedure unless the pilot determines that the RA is caused by participating test aircraft and visual with that aircraft is established.

4.4.6 Lost Link Procedures

It is standard for lost link procedures to be planned for every Ikhana flight operation. Ikhana flight crew are expected to load the appropriate lost link mission prior to each flight test encounter (IAW the test card). In the unlikely event that Ikhana experiences a lost link condition, an abort call will be made on mission frequency. In most cases, ownship will remain on heading and altitude while navigating to a point beyond the CPA. All intruder aircraft will be expected to follow their abort procedures identified on their test card. It is standard to increase vertical separation from other participating aircraft and maneuver laterally thereby increasing separation with ownship (IAW the test card procedure).

4.4.7 Post Encounter Procedures

Once test objectives are completed for a given test encounter, the Test Conductor will call “Terminate” and announce the next expected test card to be flown. All participating aircraft will fly the deconfliction altitude identified on the test card just flown and start own navigation to the next IP for the next card announced. The Test Conductor will monitor the post encounter situation using Zeus and provide real-time instructions to help facilitate separation and setup for the next test encounter.

4.5 DAA Scripted Test Encounters

4.5.1 Ownship Requirements

The NASA AFRC Predator B Ikhana aircraft is planned to be the Flight Test 4 ownship for all encounters. Ikhana will be equipped with the GA-ASI EDM radar, ADS-B, TCAS II, DAA Avionics, and DGPS. Ownship aircraft must be available to support the planned flight schedule.

4.5.2 Intruder Requirements

All Intruder aircraft require ADS-B and DGPS, except for a specific requirement for Mode C only data collection. TCAS II with onboard data recording is required for some encounters.

The Honeywell C90 is the primary intruder aircraft and it meets the TCAS II data recording requirement. A small number of planned encounters require a high speed intruder aircraft which will be met using the NASA AFRC Gulfstream GIII aircraft. Further, another small number of planned encounters require a low speed aircraft which will be met using the NASA AFRC TG-14. Some scripted encounters require two or more intruder aircraft which will be provided primarily by the NASA AFRC support aircraft fleet.

4.5.3 Minimum Separation

The minimum geospatial offsets planned are 200 ft vertical and 0 ft horizontal (although not simultaneously during any test run). Test encounters with a minimum vertical separation of <500 ft will include a lateral offset of 2430 ft (0.4 nmi) which allows for some built-in safety margin that still meets well clear volume requirements and test data collection objectives. Test encounters ≥500ft vertical offset may have a 0 ft horizontal offset.

All participating aircraft will ensure that the aircraft altimeter system meets manufacturer calibration specifications and requirements for normal operation in the NAS.

A maximum of 608 ft (0.1 nmi) navigation error (GPS derived position) is allowed for each aircraft based on the system's built-in navigation accuracy readout.

4.5.4 DAA Scripted Encounter Test Flow

Figures 23-57 depict the DAA scripted encounters required by NASA ARC, LaRC, GA-ASI, Honeywell, and SC-228 (respectively) researchers. The DAA Scripted encounters are further divided into the following flight test groupings:

- DAA Scripted, low speed intruder− encounters that requires Ikhana ownship versus a low speed intruder aircraft (TG-14);
- DAA Scripted, medium speed intruder− encounters that requires Ikhana ownship versus a medium speed intruder aircraft (Honeywell C90/King Air/T-34C);
- DAA Scripted, high speed intruder− encounters that requires Ikhana ownship versus a high speed intruder aircraft (GIII);

Additionally, encounters are divided into groups of single intruder or multiple (multiship) intruders.

Priority for test sequence will be driven by UAS-NAS PE requirements, test aircraft availability, weather conditions, airspace constraints, and test execution considerations (i.e. encounter repeat runs such as aborts, resets, system performance issues, etc.). A flight test schedule will be published that describes the planned test series based on the number of encounters, encounter priority, flight date, and other factors.

The test conductor will design a flight test order of cards prior to each flight test day that outlines the test card flow for that flight test period (Figure 21). Typically 25 test cards will make up the card order based on data collection priority for the display (or algorithm) under test.

	APRIL		MAY							
		Aural Alerts					Alerts on HUD			
	JADEM	JADEM	JADEM	JADEM/Radar	SC-228 (JADEM)	Honeywell	CPDS/TCAS	SC-228 (CPDS)	Radar	Radar
	No alt. cal.								No alt. cal. required	
	1	2	3	4	5	9	6	10	7	8
	26-Apr	28-Apr	3-May	5-May	10-May	12-May	17-May	19-May	24-May	26-May
	Tu	Th	Tu	Th	Tu	Th	Tu	Th	Tu	Th
1	001-Am-S5H	063-Am-S5M	013-Am-S5L	210-Gr-S1L	274-Sj-S5L	227-Hn-S1M	166-Gc-S5M	264-Sc-S1M	195-Gr-M1M	184-Gr-M1M
2	004-Am-S5H	065-Am-S5M	016-Am-S5L	211-Gr-S1L	271-Sj-S3L	228-Hn-S1M	165-Gc-S5M	282-Sc-S1M	188-Gr-M1M	185-Gr-M1M
3	002-Am-S5H	064-Am-S5M	014-Am-S5L	208-Gr-M1M	289-Sj-M3L	229-Hn-S1M	167-Gc-S5M	260-Sc-S5M	189-Gr-M1M	186-Gr-M1M
4	005-Am-S5H	066-Am-S5M	017-Am-S5L	209-Gr-M1M	262-Sj-S1M	230-Hn-S2M	168-Gc-S5M	261-Sc-S5M	190-Gr-M1M	187-Gr-M1M
5	003-Am-S5H	019-Am-S4M	015-Am-S5L	067-Am-M5M	280-Sj-S1M	231-Hn-S2M	169-Gc-S5M	279-Sc-S5M	191-Gr-M1M	180-Gr-M1M
6	006-Am-S5H	020-Am-S4M	018-Am-S5L	070-Am-M5M	253-Sj-S5M	232-Hn-S2M	170-Gc-S5M	245-Sc-S3M	192-Gr-M1M	196-Gr-S1M
7	007-Am-S5H	021-Am-S4M	054-Am-S5L	068-Am-M5M	277-Sj-S5M	233-Hn-S2M	171-Gc-M3M	246-Sc-S3M	176-Gr-M5M	207-Gr-S1M
8	010-Am-S5H	022-Am-S4M	055-Am-S5L	071-Am-M5M	258-Sj-S5M	238-Hn-S2M	172-Gc-M3M	269-Sc-S3M	183-Gr-M1M	206-Gr-S1M
9	008-Am-S5H	032-Am-S3M	056-Am-S5L	069-Am-M5M	266-Sj-S3M	239-Hn-S2M	174-Gc-M3M	270-Sc-S3M	177-Gr-M5M	205-Gr-S1M
10	011-Am-S5H	033-Am-S3M	044-Am-S2M	072-Am-M5M	265-Sj-S3M	234-Hn-S2M	173-Gc-M1M	247-Sc-S3M	181-Gr-M1M	204-Gr-S1M
11	009-Am-S5H	034-Am-S3M	041-Am-S2M	047-Am-M3M	283-Sj-M3M	235-Hn-S2M	175-Gc-M1M	287-Sc-M3M	178-Gr-M5M	203-Gr-S1M
12	012-Am-S5H	035-Am-S3M	045-Am-S2M	057-Am-S5M	256-Sj-S5M	236-Hn-S2M	221-Gt-S3M	291-Sc-M3M	182-Gr-M1M	202-Gr-S1M
13	048-Am-S5H	036-Am-S3M	042-Am-S2M	060-Am-S5M	254-Sj-S3M	237-Hn-S2M	222-Gt-S3M	257-Sc-S5M	179-Gr-M5M	201-Gr-S1M
14	049-Am-S5H	037-Am-S3M	046-Am-S2M	058-Am-S5M	255-Sj-S3M	240-Hn-S2M	213-Gt-S3M		194-Gr-M1M	200-Gr-S1M
15	050-Am-S5H	038-Am-S3M	043-Am-S2M	061-Am-S5M	284-Sj-M3M	241-Hn-S2M	214-Gt-S3M		193-Gr-M1M	199-Gr-S1M
16	051-Am-S5H	039-Am-S3M	026-Am-S3M	059-Am-S5M	242-Sj-S3M	223-Hn-S2M	212-Gt-S2M			198-Gr-S1M
17	052-Am-S5H	040-Am-S3M	027-Am-S3M	062-Am-S5M	243-Sj-S3M	224-Hn-S2M	215-Gt-M3M			
18	053-Am-S5H	023-Am-S3M	028-Am-S3M		250-Sj-S3M	225-Hn-S2M	216-Gt-M3M			
19		024-Am-S3M	029-Am-S3M		251-Sj-S3M	226-Hn-S2M	217-Gt-MTM			
20		025-Am-S3M	030-Am-S3M				218-Gt-MTM			
21			031-Am-S3M				219-Gt-MTM			
22							220-Gt-MTM			
23										
24										
25										
Attributes										
	High speed			High speed						
	Mid speed	Mid speed	Mid speed	Mid speed	Mid speed	Mid speed	Mid speed	Mid speed	Mid speed	Mid speed
			Low speed	Low speed	Low speed					
				Multi	Multi		Multi		Multi	Multi
					Mode C				L RCS	L RCS
									M RCS	M RCS
Aircraft										
	G-III	G-III (b/u)		G-III						
	N3GC	N3GC	N3GC	N3GC	N3GC	N3GC	N3GC	N3GC	N3GC	N3GC
	King Air (b/u)	King Air (b/u)	King Air (b/u)	King Air	T-34	King Air (b/u)	King Air	King Air (b/u)	King Air (b/u)	King Air (b/u)
				T-34	King Air (b/u)		T-34 (b/u)	T-34	T-34	T-34
			TG-14	TG-14	TG-14					
					USAF C-12					

	JUNE							
	DAIDALUS/SC-228 (CPDS/DAIDALUS)	DAIDALUS	DAIDALUS/SC-228 (DAIDALUS)	DAIDALUS/SC-228 (DAIDALUS)	DAIDALUS/SC-228 (CPDS/DAIDALUS)	*Original Flight 12*	*Original Flight 13*	*Original Flight 14*
	11	12	13	14	15	BACKUP (16)	BACKUP (17)	BACKUP (18)
	7-Jun	9-Jun	14-Jun	16-Jun	21-Jun	23-Jun	28-Jun	30-Jun
	Tu	Th	Tu	Th	Tu	Tu	Th	Tu
1	249-Sc-S3H	131-La-S3M	091-La-M3M	123-La-M3M	141-La-S3L			
2	248-Sd-S3H	136-La-S3M	095-La-M3M	127-La-M3M	144-La-S3L			
3	115-La-S3H	132-La-S3M	092-La-M3M	124-La-M3M	142-La-S3L			
4	116-La-S3H	137-La-S3M	096-La-M3M	128-La-M3M	145-La-S3L			
5	117-La-S3H	133-La-S3M	093-La-M3M	125-La-M3M	143-La-S3L			
6	118-La-S3H	138-La-S3M	097-La-M3M	129-La-M3M	146-La-S3L			
7	073-La-S3M	139-La-S3M	094-La-M3M	126-La-M3M	147-La-S3L			
8	078-La-S3M	140-La-S3M	099-La-M3M	130-La-M3M	273-Sc-S3L			
9	074-La-S3M	148-La-S3M	103-La-M3M	108-La-S3M	276-Sc-S5L			
10	079-La-S3M	150-La-S3M	100-La-M3M	110-La-S3M	272-Sd-S3L			
11	075-La-S3M	149-La-S3M	104-La-M3M	112-La-S3M	275-Sd-S5L			
12	080-La-S3M	151-La-S3M	101-La-M3M	114-La-S3M	290-Sd-M3L			
13	076-La-S3M	152-La-S3M	105-La-M3M	107-La-S3M	292-Sc-M3L			
14	077-La-S3M	153-La-S5M	102-La-M3M	109-La-S3M	285-Sd-M3M			
15	083-La-S3M	154-La-S5M	278-Sd-S5M	111-La-S3M	286-Sd-M3M			
16	087-La-S3M	163-La-S5M	259-Sd-S5M	113-La-S3M	288-Sc-M3M			
17	084-La-S3M	164-La-S5M	267-Sd-S3M	263-Sd-S1M				
18	088-La-S3M	157-La-S5M	268-Sd-S3M	281-Sd-S1M				
19	085-La-S3M	158-La-S5M	244-Sd-S3M					
20	089-La-S3M		252-Sd-S3M					
21	086-La-S3M							
22								
23								
24								
25								
Attributes								
	High speed							
	Mid speed	Mid speed	Mid speed	Mid speed	Mid speed	*Mid speed*	*Mid speed*	*Mid speed*
					Low speed			
			Multi	Multi	Multi		*Multi*	*Multi*
					Mode C			
Aircraft								
	G-III			G-III (b/u)				
	N3GC	N3GC	N3GC	N3GC	N3GC	*N3GC*	*N3GC*	*N3GC*
	King Air (b/u)	King Air (b/u)	King Air	King Air	King Air (b/u)	*King Air (b/u)*	*King Air*	*King Air*
			T-34 (b/u)	T-34 (b/u)			*T-34(b/u)*	*T-34(b/u)*
					TG-14			
					USAF C-12			

If DAIDALUS software delivery before May 23 Cutoff -

Flight 14 becomes Flight 11
Flight 15 remains the same
Flight 16 becomes Flight 12
Flight 17 becomes Flight 13
Flight 18 becomes Flight 14

Priority	1	2	3

Figure 21. DAA Flight Test 4 Encounter Priorities Worksheet and Intruder Aircraft Scheduling.

4.5.5 Flight Test Matrix

Appendix H depicts the master Flight Test 4 DAA Scripted Test Encounters Matrix, which is a detailed, multi-tabbed compilation of the DAA flight test encounter geometries. This spreadsheet informs and populates the flight test cards automatically via numerous associated tabs in the matrix spreadsheet. Each scenario is planned with unique waypoints for a geometry and timing that places both aircraft 2,430 ft horizontally from each other at the closest point of approach, if the vertical separation is <500 ft. The matrix also includes aircraft groundspeeds, test point altitudes, abort altitudes and headings, tolerances, and Ikhana Lost Link waypoints. Table 4 shows a summarized FTM.

Each aircraft will fly a straight-line or maneuvering trajectory from a known Initial Point (IP) to a known Closest Point of Approach (CPA), with some scenarios using a Maneuver Point (MP) and/or a Descent Point (DP) in between the two aforementioned points. Collectively these are the control points for each encounter. Latitude and Longitude for these points are given in the following two formats with depicted decimal precisions to support the flight management systems and navigation capabilities of participating aircraft:

Table 4. Summarized Flight Test 4 Matrix.

Item	Encounters/SUT	Stakeholder	Scenario Numbers
1	JADEM	SSI-West (ARC)	#1-72
2	DAIDALUS	SSI-East (LaRC)	#73-164
3	CPDS	GA	#165-175
4	Radar	GA	#176-211
5	TCAS	GA	#212-222
6	Tracker	Honeywell	#223-241
7	SC-228 (various)	SC-228 V&V WG	#242-292

Stakeholder	Scenario Number	PE Name/Type	Priority (1-high, 2-medium, 3-	Name	Ownship TC (IP to CPA)	Leg Time (minutes)	Total Encounter Length	Ownship Angle	Angle Into Int 1	Angle Into Int 2	Vertical Offset Int 1 (ft)	Vertical Offset Int 2 (ft)	Lateral Offset INT1 (ft)	Lateral Offset INT2 (ft)	GS OWN	GS INT1	GS INT2	GS INT3	GS INT4	O/S Above	Altitude Regime	Ownship Initial Altitude	Ownship Vertical Velocity	Ownship Final Altitude	Ownship Abort Alt	Ownship Abort Hdng	Intruder 1 Initial Altitude	Intruder 1 Vertical Velocity	Intruder 1 Final Altitude	Intruder 1 Abort Alt	Intruder 1 Abort Hdng	Intruder 2 Initial Altitude	Intruder 2 Vertical Velocity	Intruder 2 Final Altitude	Intruder 2 Abort Alt	Intruder 2 Abort Hdng	Intruder 3 Initial Altitude	Intruder 3 Vertical Velocity	Intruder 3 Final Altitude	Intruder 3 Abort Alt	Intruder 3 Abort Hdng	Intruder 4 Initial Altitude	Intruder 4 Vertical Velocity	Intruder 4 Final Altitude	Intruder 4 Abort Alt	Intruder 4 Abort Hdng
SSI WEST JADEM	001	SSIWest.1.a	1	001-Am-S5H	270	2.0	2.0		0		500		0		200	420				1	>10K MSL	15500	0	15500	15500	NTAIN HEAD	15000	0	15000	14500	123															
	002		1	002-Am-S5H	270	2.0	2.0		45		500		0		200	420				1	>10K MSL	15500	0	15500	15500	NTAIN HEAD	15000	0	15000	14500	078															
	003		1	003-Am-S5H	180	2.0	2.0		90		500		0		200	420				1	>10K MSL	15500	0	15500	15500	NTAIN HEAD	15000	0	15000	14500	213															
	004	SSIWest.1.b	2	004-Am-S5H	270	2.0	2.0		0		500		0		200	420				1	>10K MSL	16000	0	16000	16000	NTAIN HEAD	15500	0	15500	15000	123															
	005		2	005-Am-S5H	270	2.0	2.0		45		500		0		200	420				1	>10K MSL	16000	0	16000	16000	NTAIN HEAD	15500	0	15500	15000	078															
	006		2	006-Am-S5H	180	2.0	2.0		90		500		0		200	420				1	>10K MSL	16000	0	16000	16000	NTAIN HEAD	15500	0	15500	15000	213															
	007	SSIWest.1.c	1	007-Am-S5H	270	2.0	2.0		0		500		0		180	300				1	<10K MSL	9000	0	9000	9000	NTAIN HEAD	8500	0	8500	8000	123															
	008		1	008-Am-S5H	270	2.0	2.0		45		500		0		180	300				1	<10K MSL	9000	0	9000	9000	NTAIN HEAD	8500	0	8500	8000	078															
	009		1	009-Am-S5H	180	2.0	2.0		90		500		0		180	300				1	<10K MSL	9000	0	9000	9000	NTAIN HEAD	8500	0	8500	8000	213															
	010	SSIWest.1.d	2	010-Am-S5H	270	2.0	2.0		0		500		0		180	300				1	<10K MSL	9000	0	9000	9000	NTAIN HEAD	8500	0	8500	8000	123															
	011		2	011-Am-S5H	270	2.0	2.0		45		500		0		180	300				1	<10K MSL	9000	0	9000	9000	NTAIN HEAD	8500	0	8500	8000	078															
	012		2	012-Am-S5H	180	2.0	2.0		90		500		0		180	300				1	<10K MSL	9000	0	9000	9000	NTAIN HEAD	8500	0	8500	8000	213															
	013	SSIWest.1.e	1	013-Am-S5L	90	2.0	2.0		0		500		0		120	100				1	<10k MSL	9000	0	9000	9000	NTAIN HEAD	8500	0	8500	8000	213															
	014		1	014-Am-S5L	90	2.0	2.0		45		500		0		120	100				1	<10k MSL	9000	0	9000	9000	NTAIN HEAD	8500	0	8500	8000	258															
	015		1	015-Am-S5L	90	2.0	2.0		90		500		0		120	100				1	<10k MSL	9000	0	9000	9000	NTAIN HEAD	8500	0	8500	8000	213															
	016	SSIWest.1.f	2	016-Am-S5L	90	2.0	2.0		0		500		0		120	100				1	<10k MSL	9000	0	9000	9000	NTAIN HEAD	8500	0	8500	8000	213															
	017		2	017-Am-S5L	90	2.0	2.0		45		500		0		120	100				1	<10k MSL	9000	0	9000	9000	NTAIN HEAD	8500	0	8500	8000	258															
	018		2	018-Am-S5L	90	2.0	2.0		90		500		0		120	100				1	<10K MSL	9000	0	9000	9000	NTAIN HEAD	8500	0	8500	8000	213															
	019	SSIWest.2.a	1	019-Am-S4M	90	1.0	1.0		0		400		2430		150	180				0	>10k MSL	11000	0	11000	11000	NTAIN HEAD	13900	-2500	11400	12000	213															
	020	SSIWest.2.b	1	020-Am-S4M	90	1.0	1.0		0		400		2430		150	180				0	>10k MSL	11000	0	11000	11000	NTAIN HEAD	13900	-2500	11400	12000	213															

(*Continued Table 4*).

GA CPDS	165	120 and 1.5	1	165-Gc-S5M	90	3.0	3.0	30	0		500		0		150	150					>10K MSL	12000	0	12000	12000	NTAIN HEAD	11500	0	11500	11000	213															
	166	120 and 2.0	1	166-Gc-S5M	90	3.0	3.0	30	0		500		0		150	150					>10K MSL	12000	0	12000	12000	NTAIN HEAD	11500	0	11500	11000	213															
	167	120 and 2.5	1	167-Gc-S5M	90	3.0	3.0	30	0		500		0		150	150					>10K MSL	12000	0	12000	12000	NTAIN HEAD	11500	0	11500	11000	213															
	168	130 and 1.5	1	168-Gc-S5M	90	3.0	3.0	30	0		500		0		150	150					>10K MSL	12000	0	12000	12000	NTAIN HEAD	11500	0	11500	11000	213															
	169	130 and 2.0	1	169-Gc-S5M	90	3.0	3.0	30	0		500		0		150	150					>10K MSL	12000	0	12000	12000	NTAIN HEAD	11500	0	11500	11000	213															
	170	130 and 2.5	1	170-Gc-S5M	90	3.0	3.0	30	0		500		0		150	150					>10K MSL	12000	0	12000	12000	NTAIN HEAD	11500	0	11500	11000	213															
	171	DAA maneuver	1	171-Gc-M3M	270	2.0	3.0		45	180	300	500	2430	0	150	180	150				~10K	10000	0	10000	10000	NTAIN HEAD	10300	0	10300	11000	123	9500	0	9500	9000	303										
	172	1 int1 7.9 int2	1	172-Gc-M3M	180	1.7	3.0		45	90	300	1000	2430	2430	150	180	180				~10K	10000	0	10000	10000	NTAIN HEAD	10300	0	10300	11000	123	9000	0	9000	9000	303										
	173	2.4 int1 7.9 int2	1	173-Gc-M1M	180	1.7	3.0		45	90	1000	1000	2430	2430	150	180	180				~10K	10000	0	10000	10000	NTAIN HEAD	11000	-1500	10300	11000	123	9000	0	9000	9000	303										
	174	1 int1 6.2 int2	1	174-Gc-M3M	180	1.7	2.3		45	90	300	1000	2430	2430	150	180	180				~10K	10000	0	10000	10000	NTAIN HEAD	10300	0	10300	11000	123	9000	0	9000	9000	303										
	175	2.4 int1 6.2 int2	1	175-Gc-M1M	180	1.7	2.3		45	90	1000	1000	2430	2430	150	180	180				~10K	10000	0	10000	10000	NTAIN HEAD	11000	-1500	10300	11000	123	9000	0	9000	9000	303										
GA Radar	176	Statistical 1	1	176-Gr-M5M	270	1.5	4.5		22	22	1000	500	0	0	160	160	160			0	>10k MSL	12000	0	12000	12000	NTAIN HEAD	13000	0	13000	13000	123	11500	0	11500	11000	033										
	177	" 2	2	177-Gr-M5M	270	1.5	4.5		14	14	1000	1000	0	0	160	160	160			0	>10k MSL	12000	0	12000	12000	NTAIN HEAD	13000	0	13000	13000	123	11000	0	11000	11000	033										
	178	" 3	1	178-Gr-M5M	270	1.5	4.5		7	7	500	1000	0	0	160	160	160			0	>10k MSL	12000	0	12000	12000	NTAIN HEAD	12500	0	12500	13000	123	11000	0	11000	11000	033										
	179	" 4	2	179-Gr-M5M	270	3.0	3.0		0	0	500	1000	0	0	160	160	160			0	>10k MSL	12000	0	12000	12000	NTAIN HEAD	12500	0	12500	13000	123	11000	0	11000	11000	033										
	180	" 5	1	180-Gr-M1M	270	1.5	4.5		30	30	1000	1000	0	0	160	160	160			0	>10k MSL	12000	0	12000	12000	NTAIN HEAD	13000	0	13000	13000	123	11000	0	11000	11000	033										
	181	" 6	1	181-Gr-M1M	270	1.5	4.5		14	14	1000	1000	0	0	160	160	160			0	>10k MSL	12000	1000	14000	14000	NTAIN HEAD	15000	0	15000	15000	123	11000	0	11000	11000	033										
	182	" 7	1	182-Gr-M1M	270	1.5	4.5		7	7	1000	1000	0	0	160	160	160			0	>10k MSL	14000	-1000	12000	12000	NTAIN HEAD	15000	0	15000	15000	123	11000	0	11000	11000	033										
	183	" 8	2	183-Gr-M1M	270	1.5	4.5		22	22	1000	1000	0	0	160	160	160			0	>10k MSL	13000	0	13000	13000	NTAIN HEAD	16000	-1000	14000	14000	123	10000	1000	12000	12000	033										
	184	" 9	1	184-Gr-M1M	180	0.8	3.8	90	14	14	1000	1000	0	0	160	160	160			0	>10k MSL	12000	0	12000	12000	NTAIN HEAD	13000	0	13000	13000	213	11000	0	11000	11000	123										
	185	" 10	2	185-Gr-M1M	180	0.8	3.8	90	14	14	1000	1000	0	0	160	160	160			0	>10k MSL	12000	0	12000	12000	NTAIN HEAD	13000	0	13000	13000	213	11000	0	11000	11000	123										
	186	" 11	1	186-Gr-M1M	90	0.5	3.5		45	45	1000	1000	0	0	160	160	160			0	>10k MSL	12000	0	12000	12000	NTAIN HEAD	13000	0	13000	13000	303	11000	0	11000	11000	213										
	187	" 12	2	187-Gr-M1M	90	0.5	3.5		45	45	1000	1000	0	0	160	160	160			0	>10k MSL	12000	0	12000	12000	NTAIN HEAD	13000	0	13000	13000	213	11000	0	11000	11000	303										
	188	" 13	1	188-Gr-M1M	270	1.0	4.5		45	45	1000	1000	0	0	160	160	160			0	>10k MSL	12000	0	12000	12000	NTAIN HEAD	13000	0	13000	13000	123	11000	0	11000	11000	033										
	189	" 14	2	189-Gr-M1M	270	1.0	4.5		45	45	1000	1000	0	0	160	160	160			0	>10k MSL	12000	0	12000	12000	NTAIN HEAD	13000	0	13000	13000	123	11000	0	11000	11000	033										
	190	" 15	2	190-Gr-M1M	270	1.0	4.5		45	45	1000	1000	0	0	160	160	160			0	>10k MSL	12000	0	12000	12000	NTAIN HEAD	13000	0	13000	13000	123	11000	0	11000	11000	033										
	191	" 16	3	191-Gr-M1M	270	1.0	4.5		45	45	1000	1000	0	0	160	160	160			0	>10k MSL	12000	0	12000	12000	NTAIN HEAD	13000	0	13000	13000	123	11000	0	11000	11000	033										
	192	" 17	3	192-Gr-M1M	270	1.0	4.5		45	45	1000	1000	0	0	160	160	160			0	>10k MSL	12000	0	12000	12000	NTAIN HEAD	13000	0	13000	13000	123	11000	0	11000	11000	033										
	193	" 18	2	193-Gr-M1M	180	0.5	3.5		75	75	1000	1000	0	0	160	160	160			0	>10k MSL	12000	0	12000	12000	NTAIN HEAD	13000	0	13000	13000	168	11000	0	11000	11000	168										
	194	" 19	1	194-Gr-M1M	180	0.5	3.5		75	75	1000	1000	0	0	160	160	160			0	>10k MSL	12000	0	12000	12000	NTAIN HEAD	13000	0	13000	13000	168	11000	0	11000	11000	168										
	195	" 20	1	195-Gr-M1M	90	0.5	3.5		100	100	1000	1000	0	0	160	160	160			0	>10k MSL	12000	0	12000	12000	NTAIN HEAD	13000	0	13000	13000	258	11000	0	11000	11000	258										
	196	Overtaking 1	1	196-Gr-S1M	270	3.0	3.0		180		1000		0		200	150				1	>10k MSL	12000	0	12000	12000	NTAIN HEAD	13000	0	13000	13000	213															
	~~197~~	~~Overtaking 2~~	~~2~~	~~197-Gr-S1M~~					~~180~~		~~1000~~		~~0~~		~~160~~	~~160~~					~~>10k MSL~~																									
	198	Low Alt 1k AGL	2	198-Gr-S1M	90	3.0	3.0		0		1000		2430		150	180				0	1000 AGL	4200	0	4200	4200	NTAIN HEAD	5200	0	5200	5200	213															
	199	Low Alt 2k AGL	2	199-Gr-S1M	270	3.0	3.0		0		1000		2430		150	180				0	2000 AGL	5200	0	5200	5200	NTAIN HEAD	6200	0	6200	6200	123															
	200	Low Alt 3k AGL	2	200-Gr-S1M	90	3.0	3.0		0		1000		2430		150	180				0	3000 AGL	6200	0	6200	6200	NTAIN HEAD	7200	0	7200	7200	213															
	201	Low Alt 4k AGL	2	201-Gr-S1M	270	3.0	3.0		0		1000		2430		150	180				0	4000 AGL	7200	0	7200	7200	NTAIN HEAD	8200	0	8200	8200	123															
	202	Low Alt 5k AGL	2	202-Gr-S1M	90	3.0	3.0		0		1000		2430		150	180				0	5000 AGL	8200	0	8200	8200	NTAIN HEAD	9200	0	9200	9200	213															
	203	Low Alt 1k AGL	1	203-Gr-S1M	270	3.0	3.0		0		1000		2430		150	180				1	1000 AGL	5200	0	5200	5200	NTAIN HEAD	4200	0	4200	4200	123															
	204	Low Alt 2k AGL	1	204-Gr-S1M	90	3.0	3.0		0		1000		2430		150	180				1	2000 AGL	6200	0	6200	6200	NTAIN HEAD	5200	0	5200	5200	213															
	205	Low Alt 3k AGL	1	205-Gr-S1M	270	3.0	3.0		0		1000		2430		150	180				1	3000 AGL	7200	0	7200	7200	NTAIN HEAD	6200	0	6200	6200	123															
	206	Low Alt 4k AGL	1	206-Gr-S1M	90	3.0	3.0		0		1000		2430		150	180				1	4000 AGL	8200	0	8200	8200	NTAIN HEAD	7200	0	7200	7200	213															
	207	Low Alt 5k AGL	1	207-Gr-S1M	270	3.0	3.0		0		1000		2430		150	180				1	5000 AGL	9200	0	9200	9200	NTAIN HEAD	8200	0	8200	8200	123															
	208	Multiple (4)	1	208-Gr-M1M	90	2.0	2.0		0	0	1000	1000	0	2430	150	250	100	180	150	0	>10k MSL	11000	0	11000	11000	NTAIN HEAD	13000	0	13000	13000	303	9000	0	9000	9000	213	12000	0	12000	12000	168	10000	0	10000	10000	348
	209	Multiple (4)	2	209-Gr-M1M	90	2.0	2.0		0	0	1000	1000	0	2430	150	250	100	180	150	0	>10k MSL	11000	0	11000	11000	NTAIN HEAD	13000	0	13000	13000	303	9000	0	9000	9000	213	12000	0	12000	12000	168	10000	0	10000	10000	348
	210	Glider Below	1	210-Gr-S1L	270	3.0	3.0		0		1000		0		150	65				1	<10k MSL	8000	0	8000	8000	NTAIN HEAD	9000	0	9000	9000	123															
	211	Glider Above	2	211-Gr-S1L	90	3.0	3.0		0		1000		0		150	65				0	<10k MSL	9000	0	9000	9000	NTAIN HEAD	8000	0	8000	8000	213															
GA TCAS	212	TCAS Shadow	2	212-Gt-S2M	90	5.5	5.5		25.5		200		12152		120	220				0	>10K MSL	12000	0	12000	12000	NTAIN HEAD	12200	0	12200	13000	277															
	~~213~~	~~Head on Reverse~~	~~1~~	~~213-Gt-S3M~~					~~0~~		~~300~~		~~2430~~		~~TBD~~	~~TBD~~					~~>10K MSL~~		~~+1000 / -1000~~		~~0~~	~~NTAIN HEADING~~		~~-1000 FPM~~																		
	~~214~~	~~Head on Reverse~~	~~1~~	~~214-Gt-S3M~~					~~0~~		~~300~~		~~2430~~		~~TBD~~	~~TBD~~					~~>10K MSL~~		~~+1000 / -1000~~		~~0~~	~~NTAIN HEADING~~		~~-1000 FPM~~																		
	215	Strength Climb RA	1	215-Gt-S2M	90	2.0	2.0		0		200		3038		150	150				1	<10K MSL	8000	0	8000	8000	NTAIN HEAD	7800	0	7800	7000	213															
	216	Strength Climb RA	1	216-Gt-S2M	90	2.0	2.0		0		200		3038		150	150				0	<10K MSL	8000	0	8000	8000	NTAIN HEAD	8200	0	8200	9000	213															
	217	Multi Climb	1	217-Gt-M3M	90	1.22	1.8		0	0	300	450	2430	2430	165	130	130				>10K MSL	13000	1500	13350	13350	NTAIN HEAD	12700	0	12700	12000	213	13800	0	13800	14400	303										
	218	Multi Climb	1	218-Gt-M3M	90	1.22	1.8		0	0	300	450	2430	2430	165	130	130				>10K MSL	13000	1500	13350	13350	NTAIN HEAD	12700	0	12700	12000	213	13800	0	13800	14400	303										
	219	Multi Descend	1	219-Gt-M3M	90	1.22	1.8		0	0	300	500	2430	2430	165	130	130				>10K MSL	13000	-1500	12600	12600	NTAIN HEAD	13300	0	13300	14000	213	12100	0	12100	11600	303										
	220	Multi Descend	1	220-Gt-M3M	90	1.22	1.8		0	0	300	500	2430	2430	165	130	130				>10K MSL	13000	-1500	12600	12600	NTAIN HEAD	13300	0	13300	14000	213	12100	0	12100	11600	303										
	221	Do not descend 500	2	221-Gt-S4M	90	3.0	3.0		0		400		2430		150	130				1	>10K MSL	13000	0	13000	13000	NTAIN HEAD	12100	300	12600	12000	213															
	222	Do not descend 1500	2	222-Gt-S4M	90	3.0	3.0		0		400		2430		150	130				1	>10K MSL	13000	0	13000	13000	NTAIN HEAD	TBD	TBD	TBD	TBD	213															
Honeywell Tracker	223	Vert. Rate 500	2	223-Hn-S2M	90	5.0	5.0		180		200		2430		180	200					>10k MSL	9000	0	9000	9000	NTAIN HEAD	9200	+/- 500	9200	10000	033															
	224	Vert. Rate 1000	2	224-Hn-S2M	90	5.0	5.0		180		200		2430		180	200					>10k MSL	9000	0	9000	9000	NTAIN HEAD	9200	+/- 1000	9200	10000	033															
	225	Vert. Rate 1500	2	225-Hn-S2M	90	5.0	5.0		180		200		2430		180	200					>10k MSL	9000	0	9000	9000	NTAIN HEAD	9200	+/- 1500	9200	10000	033															
	226	Vert. Rate 2000	2	226-Hn-S2M	90	5.0	5.0		180		200		2430		180	200					>10k MSL	9000	0	9000	9000	NTAIN HEAD	9200	+/- 2000	9200	10000	033															
	227	Zig Zag 1	1	227-Hn-S1M	90	4.0	4.0	Zig Zag	0		1000		0		180	200					>10k MSL	9000	0	9000	9000	NTAIN HEAD	10000	0	10000	10000	213															
	228	Zig Zag 2	1	228-Hn-S1M	90	4.0	4.0	Zig Zag	0		1000		0		180	200					>10k MSL	10000	0	10000	10000	NTAIN HEAD	9000	0	9000	9000	213															
	229	Zig Zag 3	1	229-Hn-S1M	90	4.0	4.0	Zig Zag	0		1000		0		180	200					>10k MSL	11000	0	11000	11000	NTAIN HEAD	10000	0	10000	10000	213															
	230	Climb and Turn 1	1	230-Hn-S2M	90	1.4	3.1	0	45		200		2430		180	180					>10k MSL	12000	0	12000	12000	NTAIN HEAD	12200	2000	15500	13000	303															
	231	Descend and Turn 1	1	231-Hn-S2M	90	1.4	3.1	0	45		200		2430		180	180					>10k MSL	12000	0	12000	12000	NTAIN HEAD	11800	-2000	8500	11000	303															
	232	Climb and Turn 2	1	232-Hn-S2M	90	1.4	3.1	0	45		200		2430		180	180					>10k MSL	13000	0	13000	13000	NTAIN HEAD	13200	2000	16500	14000	303															
	233	Descend and Turn 2	1	233-Hn-S2M	90	1.4	3.1	0	45		200		2430		180	180					>10k MSL	13000	0	13000	13000	NTAIN HEAD	12800	-2000	9500	12000	303															
	234	Climb and Turn 1	1	234-Hn-S2M	270	1.4	3.1	45	0		200		2430		180	180					>10k MSL	11000	1000	12600	12600	NTAIN HEAD	10800	0	10800	10000	123															
	235	Descend and Turn 1	1	235-Hn-S2M	270	1.4	3.1	45	0		200		2430		180	180					>10k MSL	11000	-1000	9400	9400	NTAIN HEAD	11200	0	11200	12000	123															
	236	Climb and Turn 2	1	236-Hn-S2M	270	1.4	3.1	45	0		200		2430		180	180					>10k MSL	12000	1000	13600	13600	NTAIN HEAD	11800	0	11800	11000	123															
	237	Descend and Turn 2	1	237-Hn-S2M	270	1.4	3.1	45	0		200		2430		180	180					>10k MSL	12000	-1000	10400	10400	NTAIN HEAD	12200	0	12200	13000	123															
	238	Double Maneuver	1	238-Hn-S2M	90	1.4	3.1	0	45		200		2430		180	200					>10k MSL	11000	1000	12600	12600	NTAIN HEAD	10800	0	10800	10000	303															
	239	Double Maneuver	1	239-Hn-S2M	90	1.4	3.1	0	45		200		2430		180	200					>10k MSL	12000	1000	13600	13600	NTAIN HEAD	11800	0	11800	11000	303															
	240	Double Maneuver	1	240-Hn-S2M	270	1.4	3.1	45	0		200		2430		180	200					>10k MSL	11000	0	11000	11000	NTAIN HEAD	11200	1000	12800	12000	123															
	241	Double Maneuver	1	241-Hn-S2M	270	1.4	3.1	45	0		200		2430		180	200					>10k MSL	12000	0	12000	12000	NTAIN HEAD	12200	1000	13800	13000	123															
SC-228 V&V WG	242	1	1	242-Sj-S3M	270	2.0	2.0		0		300		2430		150	180				1	<10k MSL	9000	0	9000	9000	NTAIN HEAD	8700	0	8700	8000	123															
	243	2	1	243-Sj-S3M	270	2.0	2.0		0		300		2430		150	180				1	<10k MSL	9000	0	9000	9000	NTAIN HEAD	8700	0	8700	8000	123															
	244	3	1	244-Sd-S3M	270	2.0	2.0		0		300		2430		150	180				1	<10k MSL	9000	0	9000	9000	NTAIN HEAD	8700	0	8700	8000	123															
	245	4	2	245-Sc-S3M	270	2.0	2.0		0		300		2430		150	180				1	<10k MSL	9000	0	9000	9000	NTAIN HEAD	8700	0	8700	8000	123															
	246	5	1	246-Sc-S3M	270	2.0	2.0		0		300		2430		150	180				1	<10k MSL	9000	0	9000	9000	NTAIN HEAD	8700	0	8700	8000	123															
	247	6	1	247-Sc-S3M	270	2.0	2.0		0		300		2430		150	180				1	<10k MSL	9000	0	9000	9000	NTAIN HEAD	8700	0	8700	8000	123															
	248	7	1	248-Sd-S3H	270	2.0	2.0		0		300		2430		180	420				1	>10k MSL	15300	0	15300	15300	NTAIN HEAD	15000	0	15000	14300	123															
	249	8	1	249-Sc-S3H	270	2.0	2.0		0		300		2430		180	420				1	>10k MSL	15300	0	15300	15300	NTAIN HEAD	15000	0	15000	14300	123															
	250	9	1	250-Sj-S3M	180	2.0	2.0		90		300		2430		150	180				1	<10k MSL	9000	0	9000	9000	NTAIN HEAD	8700	0	8700	8000	213															
	251	10	1	251-Sj-S3M	180	2.0	2.0		90		300		2430		150	180				1	<10k MSL	9000	0	9000	9000	NTAIN HEAD	8700	0	8700	8000	213															
	252	11	1	252-Sd-S3M	180	2.0	2.0		90		300		2430		150	180				1	<10k MSL	9000	0	9000	9000	NTAIN HEAD	8700	0	8700	8000	213															
	253	12	1	253-Sj-S5M	180	2.0	2.0		90		500		0		150	180				0	<10k MSL	7000	1000	9000	9000	NTAIN HEAD	9500	0	9500	10000	213															
	254	13	1	254-Sj-S3M	90	3.0	3.0		180		300		2430		180	130				1	<10k MSL	9000	0	9000	9000	NTAIN HEAD	8700	0	8700	8000	123															
	255	14	1	255-Sj-S3M	90	3.0	3.0		180		300		2430		180	130				1	<10k MSL	9000	0	9000	9000	NTAIN HEAD	8700	0	8700	8000	123															
	256	15	1	256-Sj-S5M	270	2.0	2.0		180		500		0		180	130				1	<10k MSL	9500	-1000	7500	7500	NTAIN HEAD	7000	0	7000	6500	303															
	257	16	1	257-Sc-S5M	270	2.0	2.0		180		500		0		180	130				1	<10k MSL	9500	-1000	7500	7500	NTAIN HEAD	7000	0	7000	6500	303															
	258	17	1	258-Sj-S5M	270	2.0	2.0		0		500		0		150	180				0	<10k MSL	7000	1000	9000	9000	NTAIN HEAD	12500	-1500	9500	10000	123															
	259	18	1	259-Sd-S5M	270	2.0	2.0		0		500		0		150	180				0	<10k MSL	7000	1000	9000	9000	NTAIN HEAD	12500	-1500	9500	10000	123															
	260	19	1	260-Sc-S5M	270	2.0	2.0		0		500		0		150	180				0	<10k MSL	7000	1000	9000	9000	NTAIN HEAD	12500	-1500	9500	10000	123															
	261	20	1	261-Sc-S5M	270	2.0	2.0		0		500		0		150	180				0	<10k MSL	7000	1000	9000	9000	NTAIN HEAD	12500	-1500	9500	10000	123															
	262	21	1	262-Sj-S1M	270	2.0	2.0		0		1500		0		150	180				0	<10k MSL	7000	1000	9000	9000	NTAIN HEAD	12000	-1500	10500	10000	123															
	263	22	1	263-Sd-S1M	270	2.0	2.0		0		1500		0		150	180				0	<10k MSL	7000	1000	9000	9000	NTAIN HEAD	12000	-1500	10500	10000	123															
	264	23	1	264-Sc-S1M	270	2.0	2.0		0		1500		0		150	180				0	<10k MSL	7000	1000	9000	9000	NTAIN HEAD	12000	-1500	10500	10000	123															
	265	24	1	265-Sj-S3M	270	2.0	2.0		90		300		2430		150	180				1	<10k MSL	9000	0	9000	9000	NTAIN HEAD	8700	0	8700	8000	123															
	266	25	1	266-Sj-S3M	270	2.0	2.0		90		300		2430		150	180				1	<10k MSL	9000	0	9000	9000	NTAIN HEAD	8700	0	8700	8000	123															
	267	26	1	267-Sd-S3M	270	2.0	2.0		90		300		2430		150	180				1	<10k MSL	9000	0	9000	9000	NTAIN HEAD	8700	0	8700	8000	123															
	268	27	1	268-Sd-S3M	270	2.0	2.0		90		300		2430		150	180				1	<10k MSL	9000	0	9000	9000	NTAIN HEAD	8700	0	8700	8000	123															
	269	28	1	269-Sc-S3M	270	2.0	2.0		90		300		2430		150	180				1	<10k MSL	9000	0	9000	9000	NTAIN HEAD	8700	0	8700	8000	123															
	270	29	1	270-Sc-S3M	270	2.0	2.0		90		300		2430		150	180				1	<10k MSL	9000	0	9000	9000	NTAIN HEAD	8700	0	8700	8000	123															
	271	30	1	271-Sj-S3L	270	2.0	2.0		90		300		2430		150	100				1	<10k MSL	9000	0	9000	9000	NTAIN HEAD	8700	0	8700	8000	213															
	272	31	1	272-Sd-S3L	270	2.0	2.0		90		300		2430		150	100				1	<10k MSL	9000	0	9000	9000	NTAIN HEAD	8700	0	8700	8000	213															
	273	32	1	273-Sc-S3L	270	2.0	2.0		90		300		2430		150	100				1	<10k MSL	9000	0	9000	9000	NTAIN HEAD	8700	0	8700	8000	213															
	274	33	1	274-Sj-S5L	270	2.0	3.0		0		500		3200		150	100				0	<10k MSL	6500	1000	8500	8500	NTAIN HEAD	9000	0	9000	9500	123															
	275	34	1	275-Sd-S5L	270	2.0	3.0		0		500		3200		150	100				0	<10k MSL	6500	1000	8500	8500	NTAIN HEAD	9000	0	9000	9500	123															
	276	35	1	276-Sc-S5L	270	2.0	3.0		0		500		3200		150	100				0	<10k MSL	6500	1000	8500	8500	NTAIN HEAD	9000	0	9000	9500	123															
	277	36	1	277-Sj-S5M	0	2.0	2.0	90	0		500		2430		150	180				0	<10k MSL	7000	1000	9000	9000	NTAIN HEAD	9500	0	9500	10000	213															
	278	37	1	278-Sd-S5M	0	2.0	2.0	90	0		500		2430		150	180				0	<10k MSL	7000	1000	9000	9000	NTAIN HEAD	9500	0	9500	10000	213															
	279	38	1	279-Sc-S5M	0	2.0	2.0	90	0		500		2430		150	180				0	<10k MSL	7000	1000	9000	9000	NTAIN HEAD	9500	0	9500	10000	213															
	280	39	2	280-Sj-S1M	270	2.0	2.0		0		1500		0		150	180				0	<10k MSL	9000	0	9000	9000	NTAIN HEAD	12000	-1500	10500	10000	123															
	281	40	2	281-Sd-S1M	270	2.0	2.0		0		1500		0		150	180				0	<10k MSL	9000	0	9000	9000	NTAIN HEAD	12000	-1500	10500	10000	123															
	282	41	2	282-Sc-S1M	270	2.0	2.0		0		1500		0		150	180				0	<10k MSL	9000	0	9000	9000	NTAIN HEAD	12000	-1500	10500	10000	123															
	283	42	1	283-Sj-M3M	270	2.0	2.0		0	0	300	300	2430	2430	150	180	180			1	<10k MSL	9000	0	9000	9000	NTAIN HEAD	8700	0	8700	8000	123	8700	0	8700	8000	033										
	284	43	1	284-Sj-M3M	270	2.0	2.0		0	0	300	300	2430	2430	150	180	180			1	<10k MSL	9000	0	9000	9000	NTAIN HEAD	8700	0	8700	8000	123	8700	0	8700	8000	033										
	285	44	1	285-Sd-M3M	270	2.0	2.0		0	0	300	300	2430	2430	150	180	180			1	<10k MSL	9000	0	9000	9000	NTAIN HEAD	8700	0	8700	8000	123	8700	0	8700	8000	033										
	286	45	1	286-Sd-M3M	270	2.0	2.0		0	0	300	1700	2430	2430	150	180	180			1	<10k MSL	9000	0	9000	9000	NTAIN HEAD	8700	0	8700	8000	123	10700	0	10700	10700	123										
	287	46	1	287-Sc-M3M	270	2.0	2.0		0	0	300	1700	2430	2430	150	180	180			1	<10k MSL	9000	0	9000	9000	NTAIN HEAD	8700	0	8700	8000	123	10700	0	10700	10700	123										
	288	47	1	288-Sc-M3M	270	2.0	2.0		0	0	300	1700	2430	2430	150	180	180			1	<10k MSL	9000	0	9000	9000	NTAIN HEAD	8700	0	8700	8000	123	10700	0	10700	10700	123										
	289	48	1	289-Sj-M3L	90	2.0	2.0		180	0	300	1000	2430	2430	150	100	150			1	<10k MSL	9000	0	9000	9000	NTAIN HEAD	8700	0	8700	8000	123	10000	0	10000	10000	303										
	290	49	1	290-Sd-M3L	90	2.0	2.0		180	0	300	1000	2430	2430	150	100	150			1	<10k MSL	9000	0	9000	9000	NTAIN HEAD	8700	0	8700	8000	123	10000	0	10000	10000	303										
	291	50	1	291-Sc-M3M	90	2.0	2.0		180	0	300	1000	2430	2430	180	130	150			1	<10k MSL	9000	0	9000	9000	NTAIN HEAD	8700	0	8700	8000	123	10000	0	10000	10000	303										
	292	51	1	292-Sc-M3L	90	2.0	2.0		180	0	300	1000	2430	2430	150	100	150			1	<10k MSL	9000	0	9000	9000	NTAIN HEAD	8700	0	8700	8000	123	10000	0	10000	10000	303										

Manned AC Lat/Long: DD MM.MM/DDD MM.MM

UAS Lat/Long: DD MM SS.S/DDD MM SS.S

This decimal precision will allow navigation to be within +/-10 feet of programmed waypoints.

One of the primary sources of trajectory/CPA prediction uncertainty is winds aloft. The FT4 scenarios were designed to be flown with a constant groundspeed and track. Constant groundspeed facilitates more accurate flying with respect to the target CPA. However, real aircraft typically fly constant airspeed while maintaining constant ground track (i.e., flight plan). By flying constant groundspeed, the pilot minimizes the effect of wind on trajectory prediction error. Moreover, the self-separation algorithms were being tested against unrealistic flight conditions.

The constant groundspeed-constant airspeed flight procedure is designed to address both CPA precision and realistic flight condition. In this procedure, the aircraft will fly to the Initial Point (IP) at the target groundspeed and timing.

4.5.6 Flight Test Geometries

DAA flight test encounters are divided into seven (stakeholder) series types based on whether the encounter requires a low/medium/high speed intruder or is a multi-ship test encounter. Figure 22 describe the nomenclature that was designed to describe the nearly 300 flight encounters that make up the Flight Test 4 encounter series. The primary form of encounter identification for FT4 is the Scenario Number (S/N), unique to each encounter.

FT4 Nomenclature

[Encounter] – [Stakeholder] – [Intruders] [Min Altitude Offset] [Speed]

- Encounter Number
  - ###
- Stakeholder
  - Am = Ames
  - La = Langley
  - Gc = GA CPDS
  - Gr = GA Radar
  - Gt = GA TCAS
  - Hn = Honeywell
  - Sj = SC-228 JADEM
  - Sd = SC-228 DAIDALUS
  - Sc = SC-228 CPDS
- Intruders
  - S = Single
  - M = Multiple
- Minimum Altitude Offset
  - 1 = 1000 ft
  - 2 = 200 ft
  - 3 = 300 ft
  - 4 = 400 ft
  - 5 = 500 ft
- Speed (Intruder)
  - L = Low
  - M = Medium
  - H = High

- Example 1:
  001 – Am – S1M

  Encounter 1, Ames, Single Intruder, 1000 ft vertical separation, medium speed intruder
- Example 2:
  145 – La – M3H

  Encounter 145, Langley, Multiple Intruders, 300 ft vertical separation, high speed intruder
- Speed
  Low: 100 KGS
  Medium: 150 – 210 KGS
  High: >250 KGS

Version: 2016-03-24

Figure 22. DAA Scripted Test Encounter Nomenclature.

4.5.6.1 SSI-West Encounter Geometry

NASA Ames designed encounters to test their DAA system in various flight test encounters to meet their objectives for data collection. SSI-West objectives are broken up as follows:

1. Validate DAA requirements in stressing cases that drive MOPS requirements, including: High-speed cooperative intruder, Low-speed non-cooperative intruder, high vertical closure rate encounter, and Mode C only intruder (i.e. without ADS-B).

2. Validate TCAS/DAA alerting and guidance interoperability concept in the presence of realistic sensor, tracking and navigational errors and in multiple-intruder encounters against both cooperative and non-cooperative intruders.
3. Validate 'Well Clear Recovery' guidance in the presence of realistic sensor, tracking and navigational errors.
4. Validate DAA alerting and guidance requirements in the presence of realistic sensor, tracking and navigational errors.
5. Collect data to support development and validation of trajectories specified in the DAA MOPS for DAA system acceptance testing.
6. Collect data to supplement simulation analyses as needed due to highly variable, preliminary or inconclusive simulation results, leveraging data from other test cases when possible (e.g., 'well clear recover' validation to supplement mini-HitL results if necessary).

Objectives 5 & 6 are 'targets of opportunity' and will rely on data collected in the other encounters to meet the stated SSI FT4 objectives. No new FT4 requirements will be levied from these objectives, but encounters may be refined to more closely match those detailed in the SC-228 verification test trajectories where practical.

Test encounters include unmitigated maneuvering and mitigated (or display) maneuvering, as well as, collecting TCAS/DAA interoperability and Well Clear Recovery (WCR) data.

Unmitigated scenarios are designed to collect data to validate CPA predictions. Self-separation advisories are also recorded, but not acted upon, during the entire duration of the scenario. The term unmitigated refers to an encounter with no self-separation (i.e., mitigating) maneuver and has been cited in previous UAS research. Aircraft in the unmitigated scenarios fly towards a target CPA. Neither aircraft maneuvers until after the CPA has been reached. Actual CPA is not critical since any CPA can be compared to the CPA predictions. It is desirable, however, to fly close enough to trigger a self-separation alert (+/- 1.2 nmi for VSCS).

The Display Maneuver scenarios are where the pilot maneuvers the aircraft as directed by the specific self-separation display. In addition to recorded data, the pilot may be asked to provide answers to post-encounter questionnaire.

DAA alerting and guidance and TCAS-II alerting and guidance both intend to mitigate mid-air collisions, but are not currently designed to interoperate. The TCAS interoperability scenarios are designed to evaluate interoperability features between TCAS and DAA systems. DAA systems are expected to keep the ownship well clear of an intruder. Although well clear is not specifically defined to avoid alerting the intruder's TCAS, alerting TCAS can generally be considered not well clear. Ideally, the DAA alert would trigger long before the TCAS alert. The TCAS interoperability maneuvers are to be flown unmitigated until the intruder's TCAS is alerted. Because CPA precision is critical, these encounters should be flown at constant groundspeed. Ideally the flights would not maneuver before the CPA, but this is not a requirement in lieu of safety. The TCAS scenarios require TCAS alerts to be recorded from the intruder aircraft.

Well Clear Recovery scenarios are designed to test the DAA display mode when guidance is provided to the pilot to regain well clear. The encounters are flown as mitigated encounters, but the pilot will be instructed to ignore corrective and warning DAA alerts and instead respond to the DAA WCR once the aircraft can no longer stay well clear. TCAS RAs are ignored in this scenario, unless there is concern for safety of flight.

JADEM will require the use of a high speed, medium speed, and low speed intruders, speeds as defined in the previously discussed Figure 22.

Figure 23 depicts NASA ARC JADEM high speed intruder encounters required to collect data to validate CPA predictions for encounters where the intruder aircraft has jet aircraft representative airspeeds. Encounters of this type will be flown unmitigated and mitigated, and additionally at altitudes both above 10k ft MSL (425 KGS intruder) and below 10k ft MSL (300 KGS intruder). In addition, this set of encounters will be flown with Well Clear Recovery guidance.

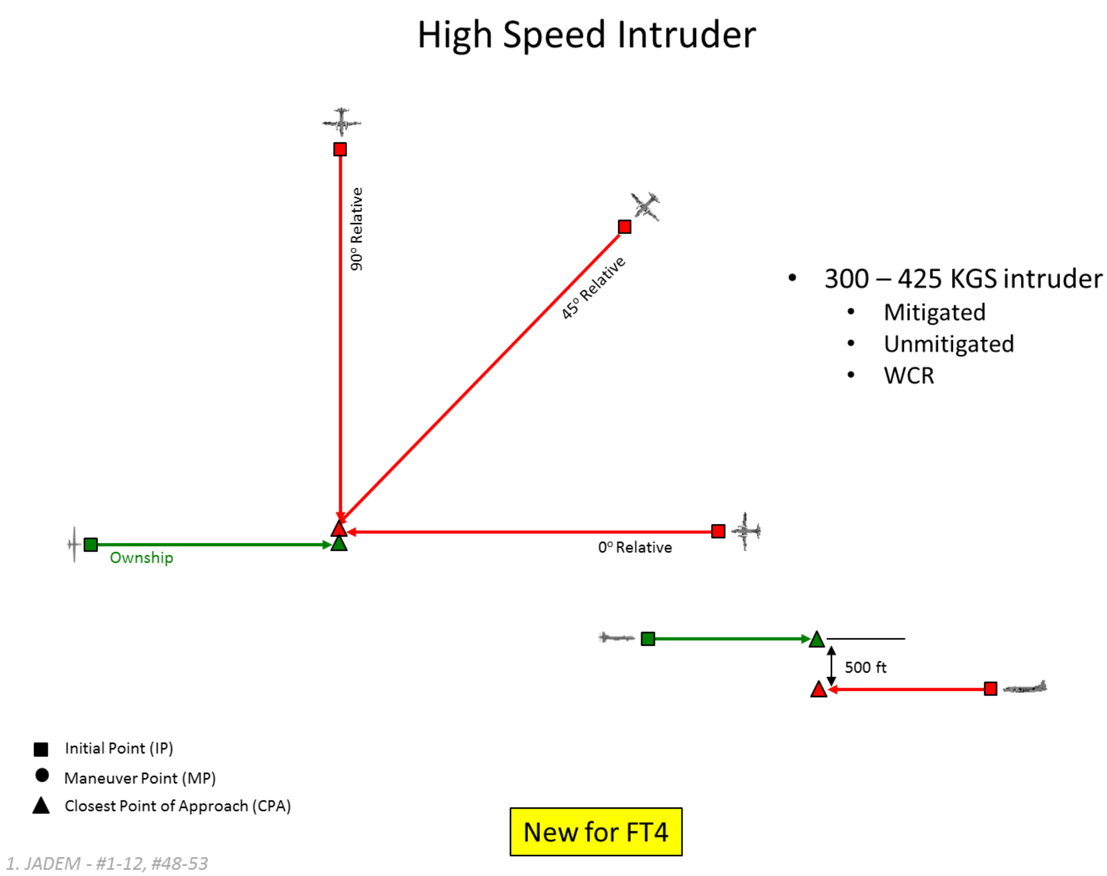


Figure 23. JADEM High Speed Intruder Encounters.

Figures 24 shows JADEM encounters that will require a medium speed intruder, with TCAS recording for TCAS interoperability encounters.

Figure 24 shows the two types of single intruder TCAS interoperability JADEM encounters. The first type is with intruder descending at a high descent rate, in this case 2500 fpm. These encounters will be flown above and below 10k ft MSL, due to the change in TCAS alerting threshold at those altitudes. The second encounter type requires the intruder to fly at various angles at the ownship and at the two specified altitudes. Since the threshold is different under 10k ft MSL, the vertical separation is also required to be as low as 200 ft to ensure proper alerting is achieved.

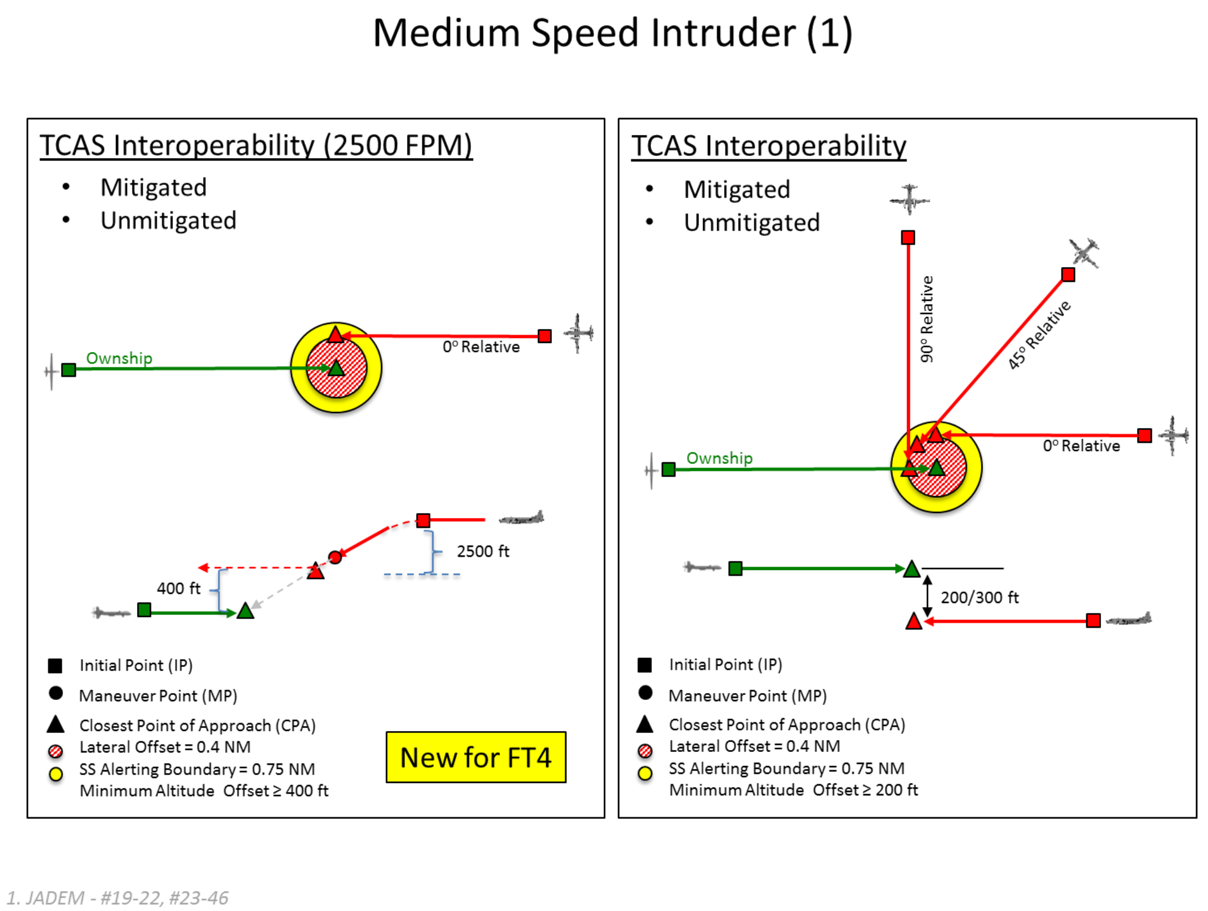


Figure 24. JADEM Medium Speed Intruder Encounters (1).

Figure 25 shows DAA medium speed intruder mitigated/unmitigated and maneuvering encounters, which will essentially be a repeat of select encounters flown during FT3.

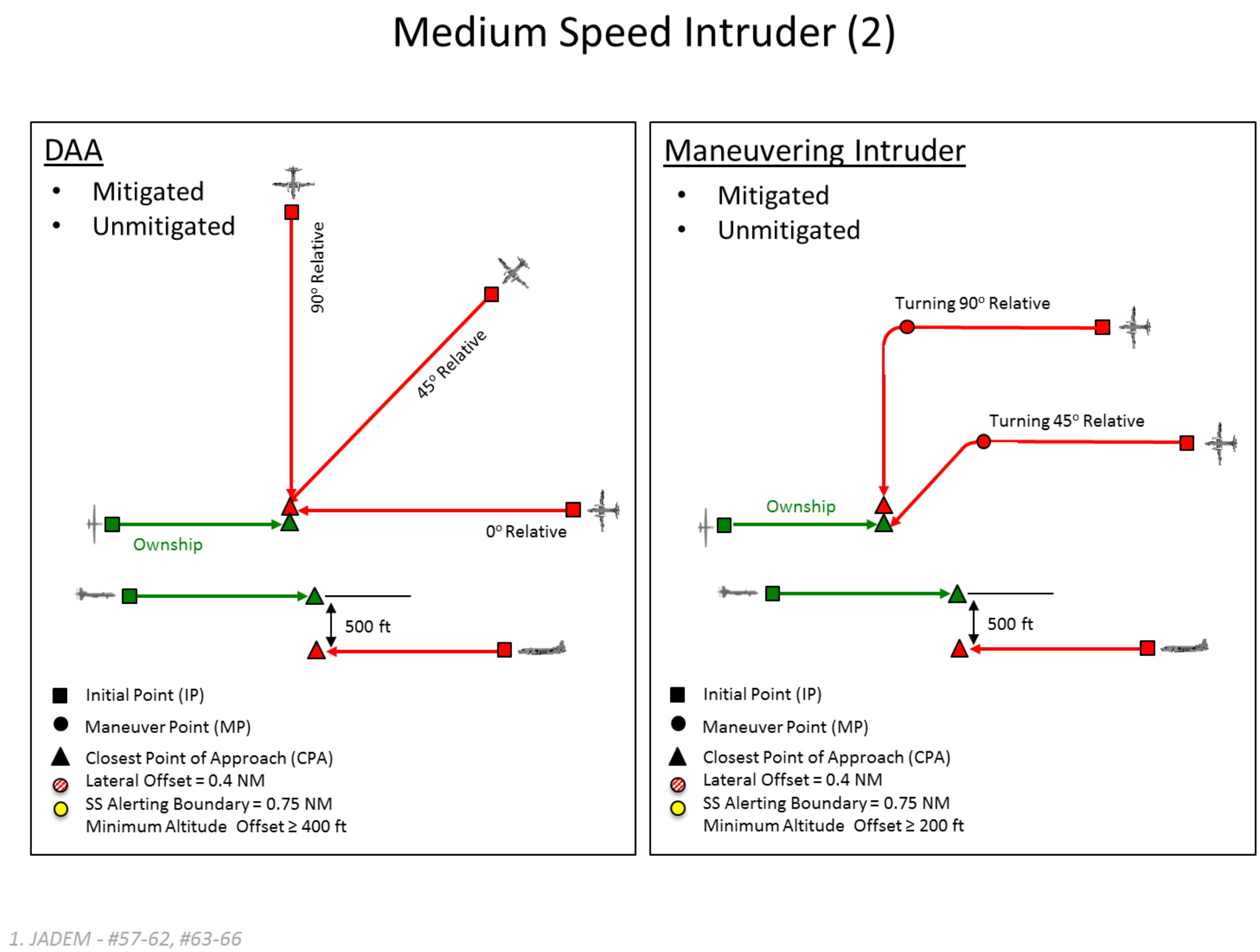


Figure 25. JADEM Medium Speed Intruder Encounters (2).

Similar to the high speed intruder encounters, SSI-West requires mitigated, unmitigated, and WCR encounters flown with a low speed intruder. These encounters are shown in Figure 26 and will all be flown below 10k ft MSL.

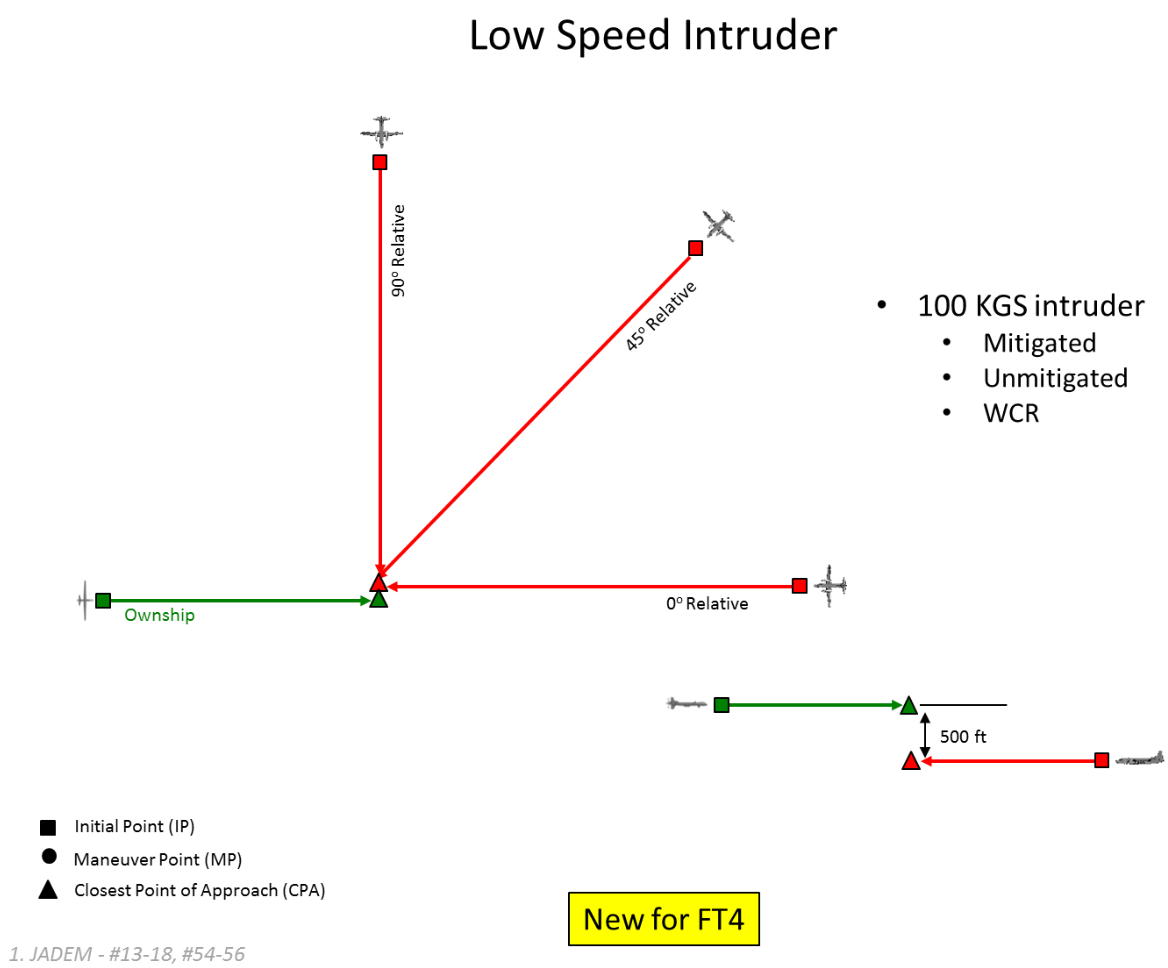


Figure 26. JADEM Low Speed Intruder Encounters (3).

Multiship encounters are also required for the SSI-West JADEM algorithm. The multiple intruder series of scenarios are designed to constrain the solution space presented to the pilot and to evaluate the JADEM solution. These scenarios increase the complexity of the solution and increase the complexity of data presented to the pilot as there may be solutions which are constrained to either side of the aircraft's course. For an SAA system to operate effectively in the NAS it must be able to solve a multiple intruder scenario even though this may be a very low probability scenario. Figure 27 shows encounters which JADEM requires for FT4, that are also essentially a repeat of FT3 for additional data acquisition.

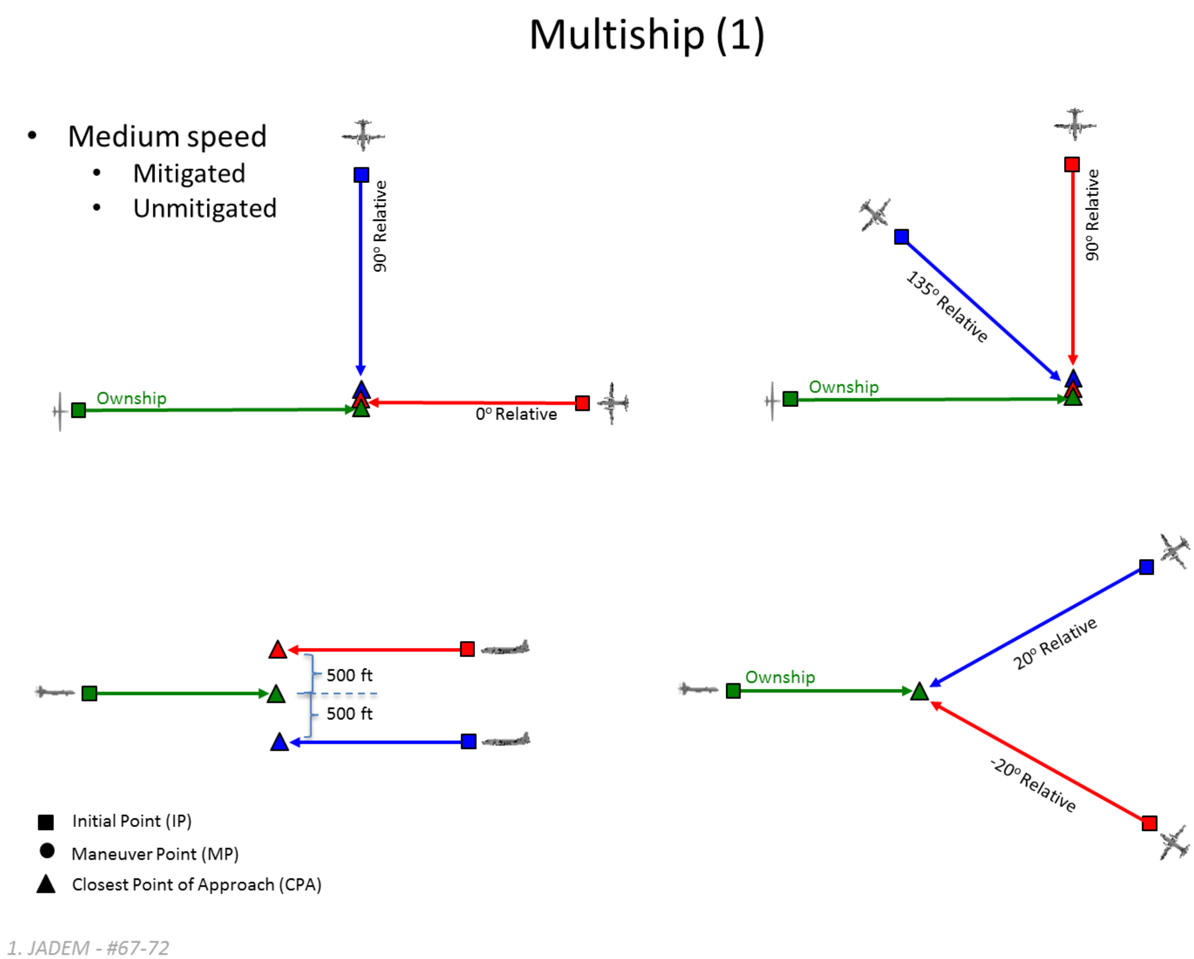


Figure 27. JADEM Multiship Intruder Encounters (1).

Figure 28 depicts the second stage of complexity for multiship encounters, new for FT4. This TCAS interoperability multiship encounter requires ownship to fly the line until a corrective TCAS RA is received from maneuvering intruder 1 (red). The ownship will comply with the TCAS guidance and descend. A minute after, the pilot will receive DAA guidance for intruder 2 (blue) and maneuver based on that following guidance. Additionally, intruder 2 is a radar-only target – transponder off. These types of encounters will be coordinated with SPORT beforehand.

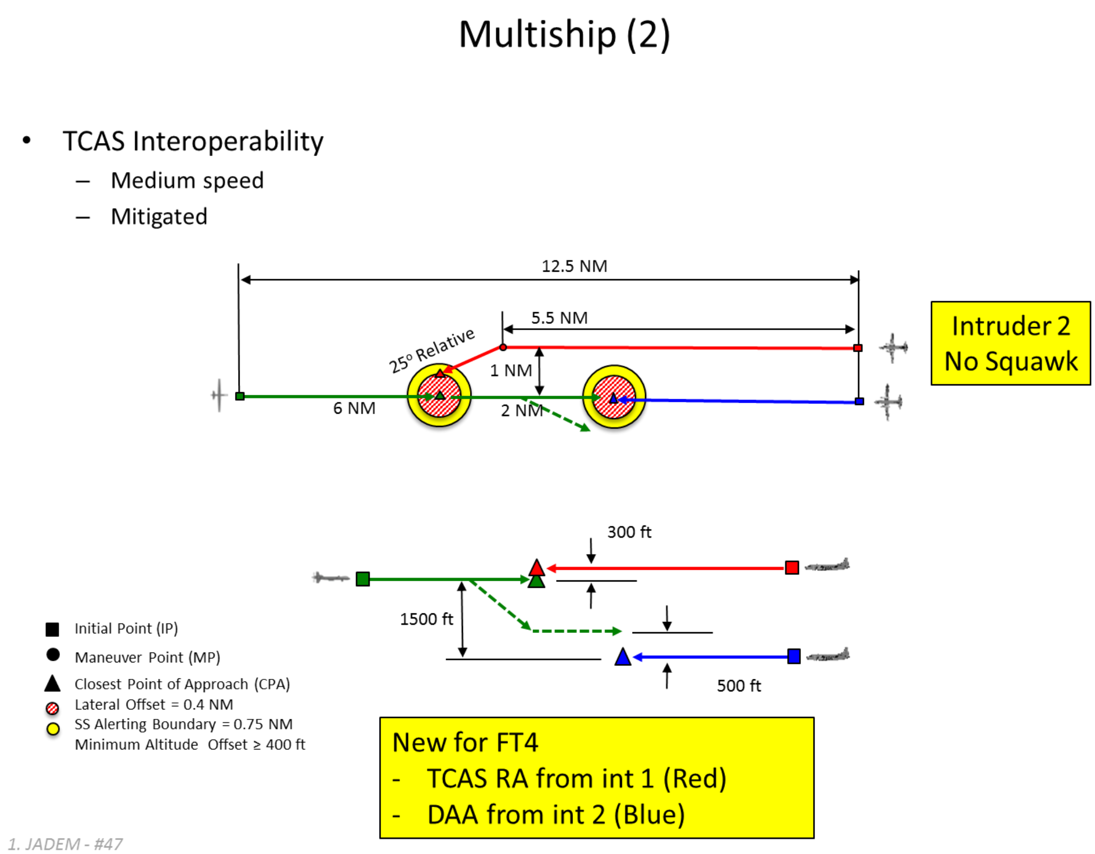


Figure 28. JADEM Multiship Intruder Encounters (2).

4.5.6.2 SSI-East Encounter Geometry

NASA Langley designed self-separation encounters to test and collect data on their self-separation algorithm DAIDALUS (Detect & AvoID Alerting Logic for Unmanned Systems) using mitigated (pilot follows displayed guidance), unmitigated, and WCR flight test encounters. This series of scenarios is designed to collect data to validate CPA predictions and validate the DAIDALUS solution well clear band data during live flight test conditions. The encounters will also operate on the edge of the TCAS RA envelope and ensure DAIDALUS guidance provides maneuver bands to operate outside the RA envelope of TCAS II. Researchers plan to analyze the TCAS II data of ownship and intruder, where available, to ascertain where a Self-Separation maneuver would have conflicted with the RA envelope. DAIDALUS requires a high speed, medium speed, and low speed intruder.

The high speed intruder scenarios are designed to evaluate the effectiveness of the DAIDALUS algorithm when engaging intruders operating at speeds typically encountered with commercial jet transport aircraft transiting below Class A airspace. The increased intruder speed will shorten the available pilot reaction time and provide faster closure while the UA starts to execute the maneuver to remain well clear. It is also of interest to evaluate if alerting times effective at lower closure rates with slower intruders will remain sufficient with higher closure speeds. This testing will enable researchers to analyze the TCAS II data of ownship and intruder, where available, to ascertain where a Self-Separation maneuver would have conflicted with the TCAS II RA envelope.

Figure 29 shows the required high speed encounters for the DAIDALUS algorithm. In addition to high speed, the intruder will maneuver into the flight path of the ownship at 45 and 90 degree relative angles, turning both from the front of ownship and from behind. This increases complexity and will gather data on a high speed intruder transitioning to a threat. The encounters are expected to be mitigated.

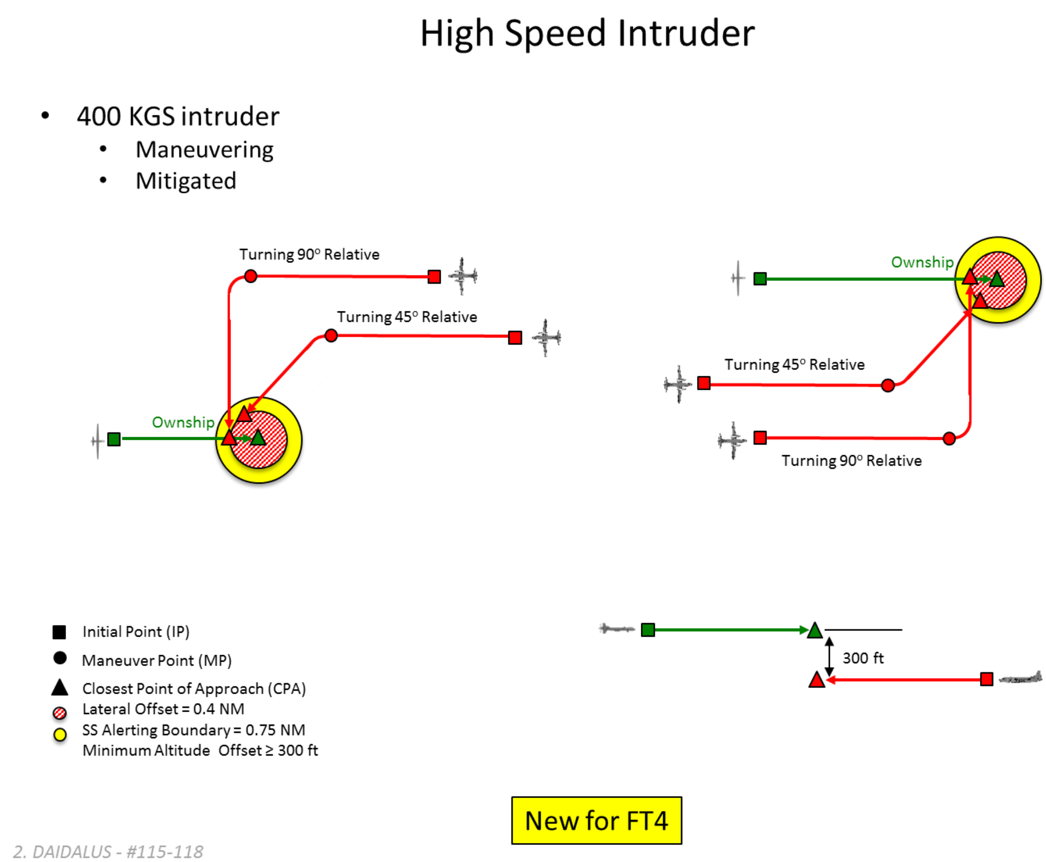


Figure 29. DAIDALUS High Speed Intruder Encounters.

Figures 30-32 depict the set of medium speed intruder encounters for DAIDALUS.

Figure 30 demonstrates the first set of encounters, where geometry angles will include 0, 45, 90, 135, and 180 degree geometries. The 135 degree geometry is of particular interest to evaluate the effectiveness of DAIDALUS in a late intruder discovery scenario where radar is operating at the edge of its azimuth. The 180 degree relative is also of interest, as ownship overtakes intruder. These encounters will be flown mitigated, with WCR, and with a select few chosen for fly-through (unmitigated) data collection. The other set of encounters in Figure 30 will have ownship following vertical guidance from DAIDALUS, a change from FT3, where all guidance was lateral.

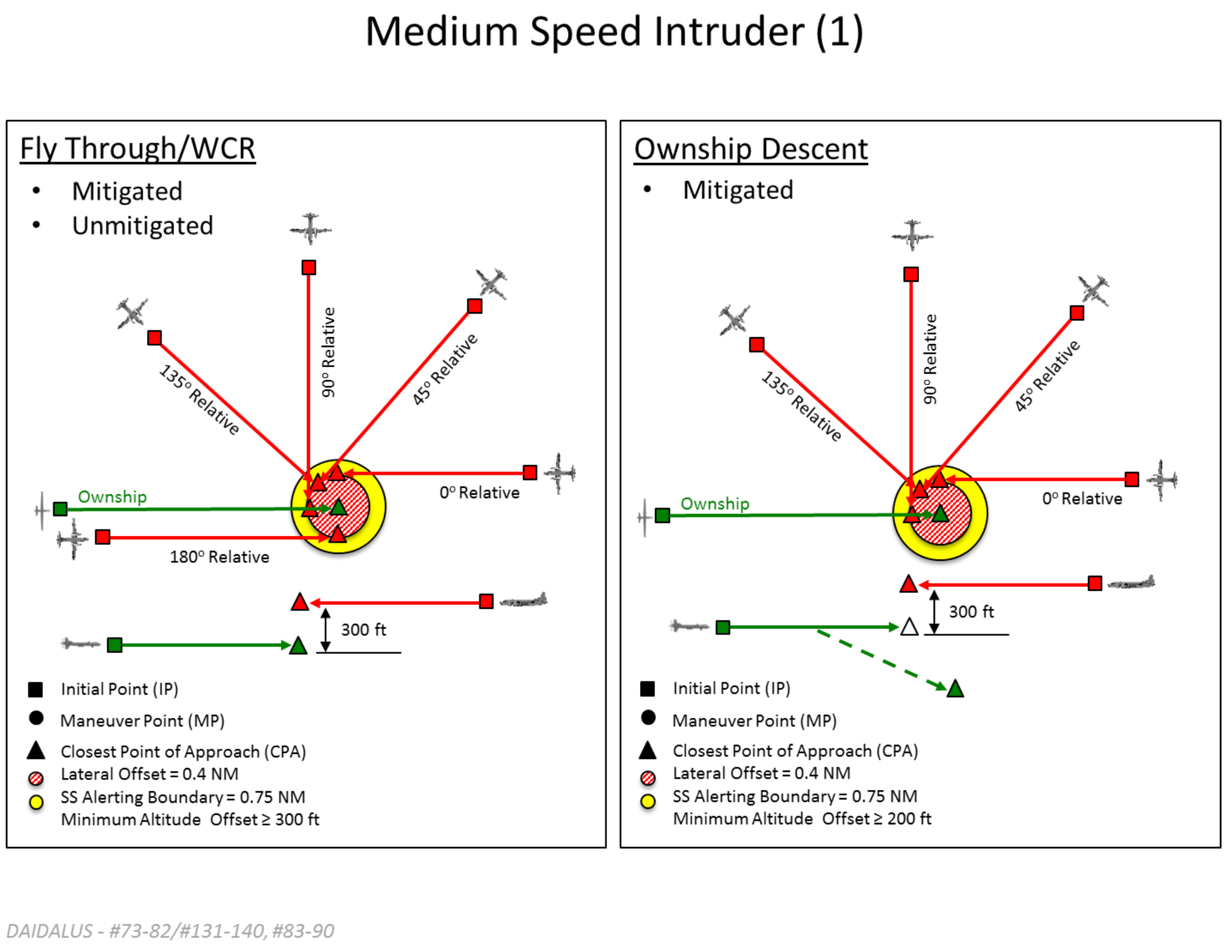


Figure 30. DAIDALUS Medium Speed Intruder Encounters (1).

Figure 31 shows the next set of medium speed intruder encounters, with the intruder maneuvering into the ownship flight path 45 and 90 degrees relative. These intruder paths will maneuver from in front of and behind ownship. The purpose of this set of encounters is to watch for TCAS RAs above and below 10k ft MSL and terminate the encounter when the RA is received. A DAIDALUS maneuver will be secondary. TCAS recording will be required for this set of encounters.

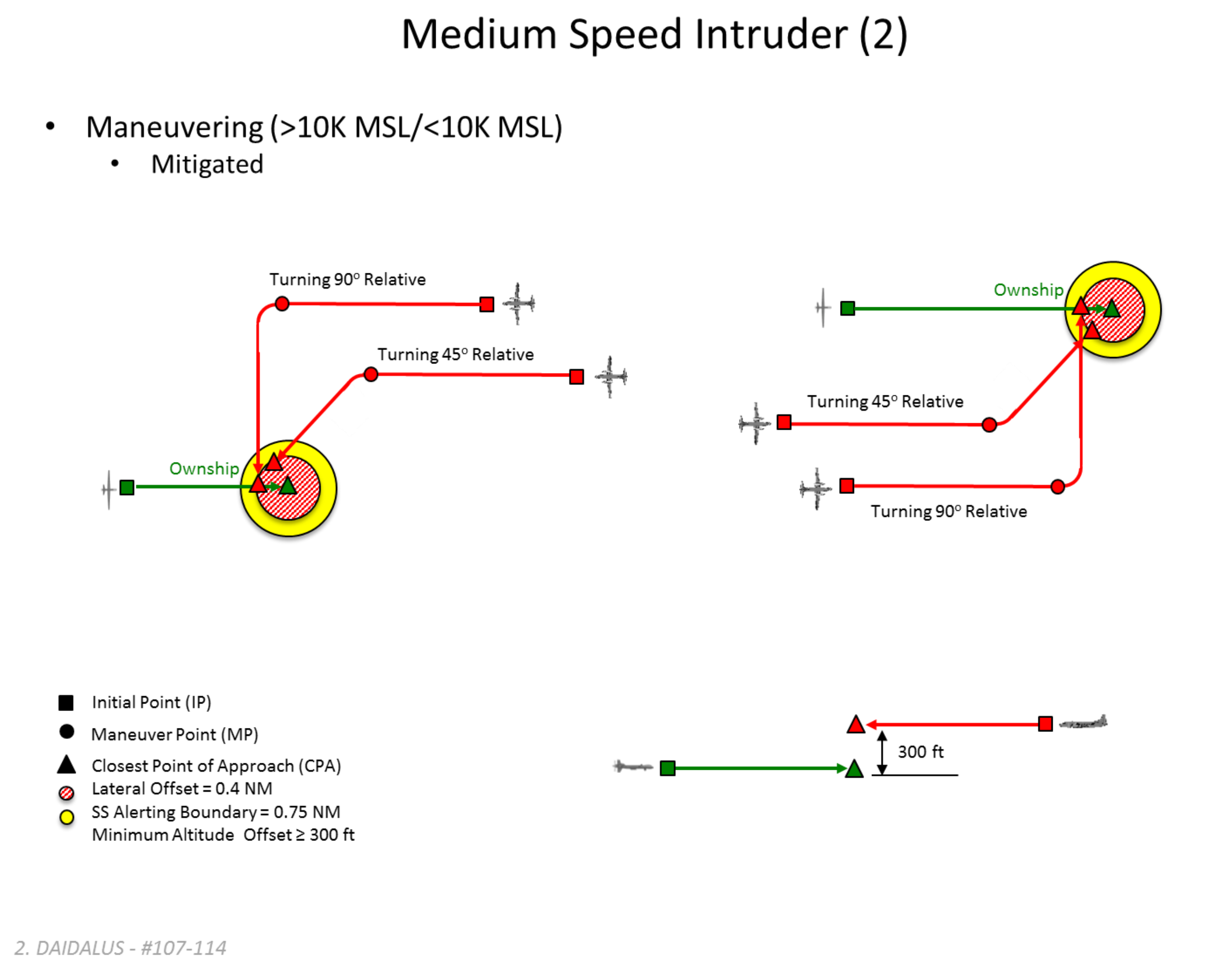


Figure 31. DAIDALUS Medium Speed Intruder Encounters (2).

Figure 32 describes a new set of DAIDALUS encounters for FT4: intruder acceleration and intruder high descent rate. For intruder acceleration encounters, the intruder will be expected to accelerate 50 to 80 KGS so as to place its CPA inside the well clear volume of ownship. The ownship pilot will then follow DAIDALUS guidance. The high intruder descent rate encounters will be flown at 1000 fpm and 3000 fpm, with the encounter being mitigated. These stressing intruder vertical maneuvers will represent additional evaluation of the DAIDALUS algorithm performance and also potentially engage the TCAS II RA envelope.

In addition to high and medium speed intruder encounters, a set of low speed intruder encounters are planned for DAIDALUS. Depicted in Figure 33, these encounters will all be flown mitigated and below 10k ft MSL.

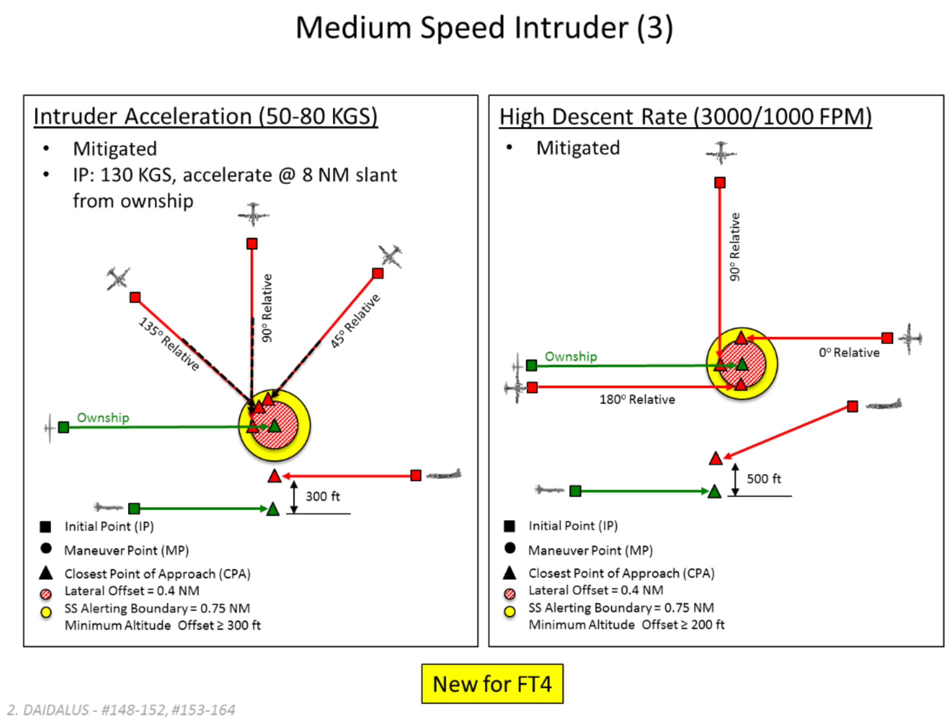


Figure 32. DAIDALUS Medium Speed Intruder Encounters (3).

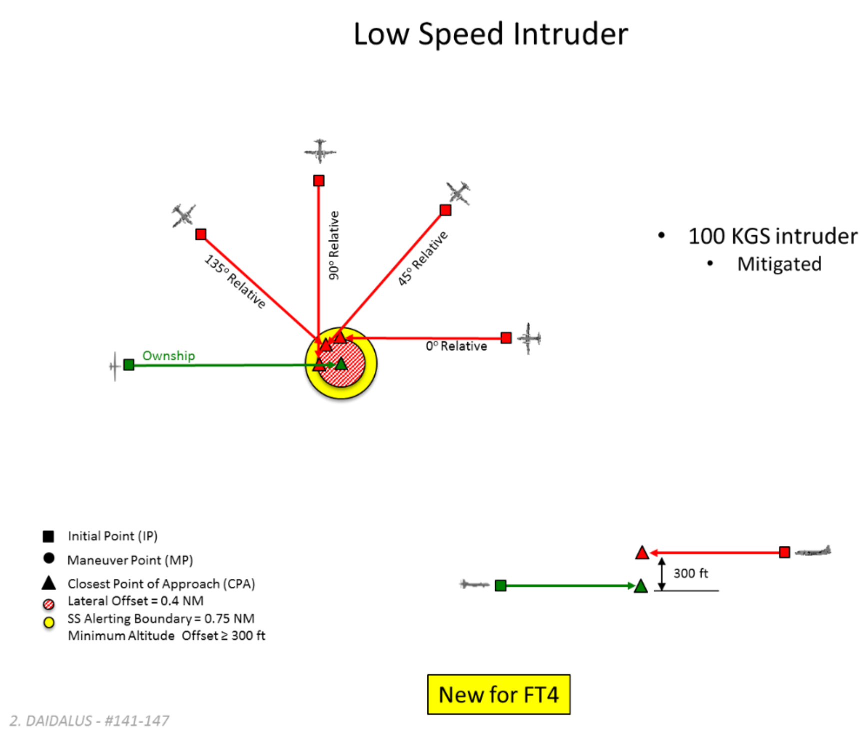


Figure 33. DAIDALUS Low Speed Intruder Encounters.

SSI-East will require its own set of multiship intruder encounters in order to constrain the solution space for the DAIDALUS algorithm. The multiship encounters for DAIDALUS are shown in Figures 34 and 35.

Figure 34 shows a new type of multiship encounter for DAIDALUS, with second intruder at a specified lateral separation from ownship blocking the DAA maneuver either horizontally or vertically. The second intruder will constrain the solution space for the alerting that ownship will receive from intruder 1. These encounters will be flown mitigated, with the pilot following DAIDALUS guidance in lateral or vertical space for ownship.

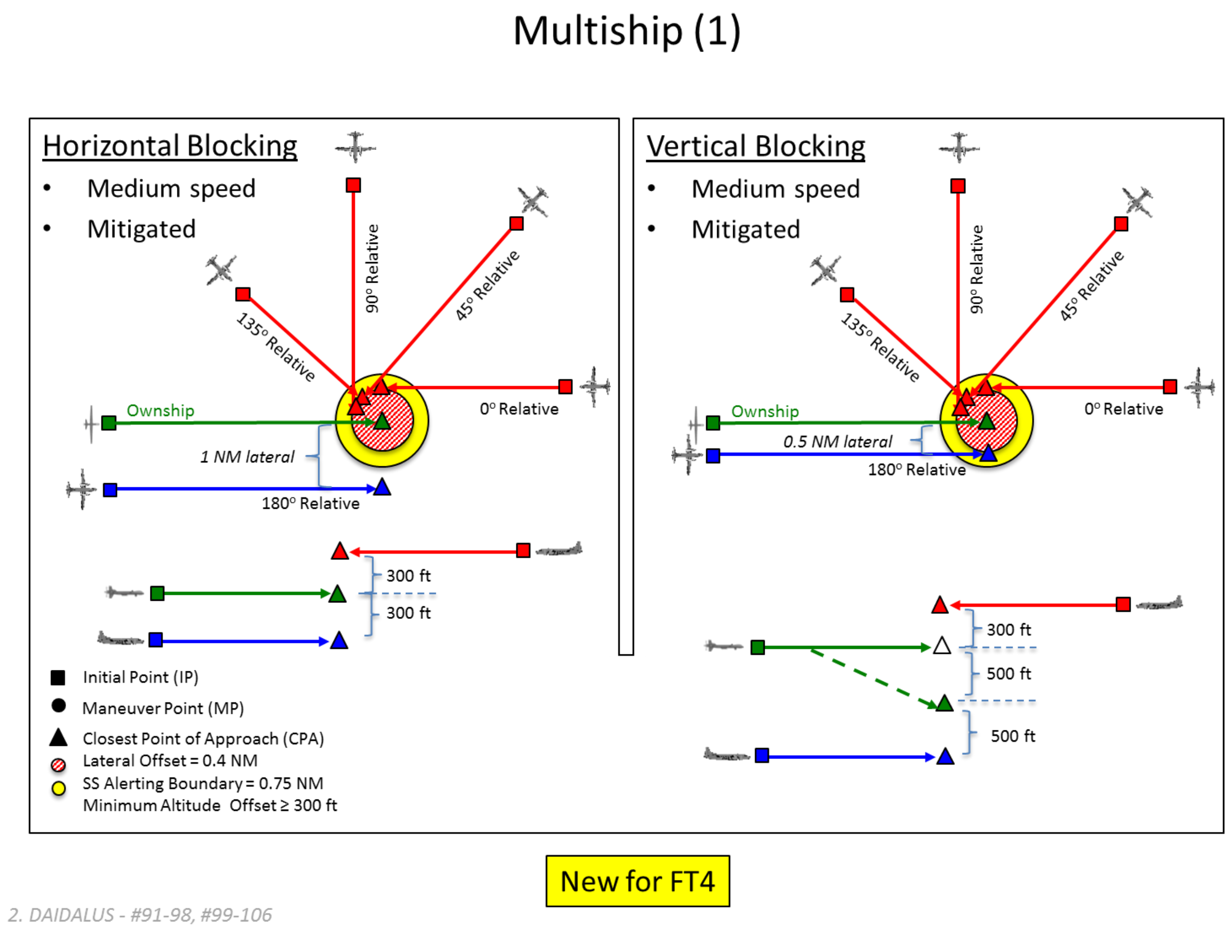


Figure 34. DAIDALUS Multiship Intruder Encounters (1).

The third type of multiship encounter is a combination of horizontal blocking and maneuvering intruder. Figure 35 shows this type of encounter. Intruder 1 will begin a maneuver 45 or 90 degree relative into from in front of or behind the ownship, with the second intruder holding a set lateral distance from ownship. These encounters will be mitigated with a DAIDALUS display maneuver from ownship.

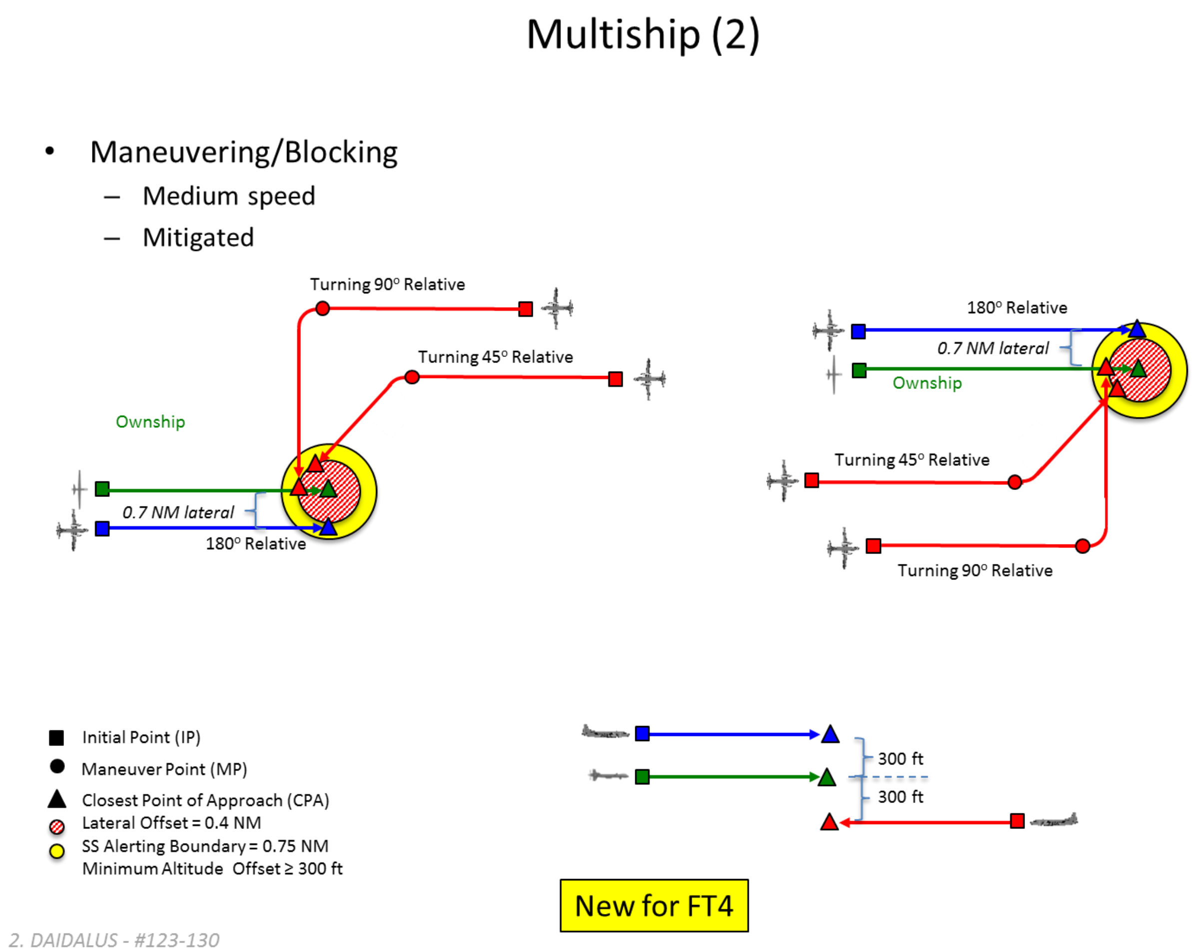


Figure 35. DAIDALUS Multiship Intruder Encounters (2).

4.5.6.3 GA-ASI Encounter Geometry - CPDS

For FT4, CPDS encounters are separated into two sections: first, encounters where a previously undetected intruder comes into the radar FOV, and second, an RA maneuver from a primary intruder causes a DAA alert from a second intruder.

The first is a particularly challenging encounter in which during the ownship traffic avoidance maneuver, a previously undetected intruder appears at a location where it threatens to cause a near-future loss of well clear. Figures 36 and 37 depict this situation. Ownship flies with the intruder either at 120 or 130 degrees bearing, at a specified range (1.5, 2, or 2.5 nmi). The ownship and intruder fly at the same groundspeed. Once the ownship and intruder are stabilized, ownship begins a 30 degree change of heading towards intruder at standard rate of turn for 1 minute, at which moment it detects the previously undetected intruder 1. Based on what kind of, and when it receives alerting, the next encounter is flown, for a maximum of 4 CPDS encounters of this type for FT4. The flow down logic for the order of encounters flown is shown in Figure 38.

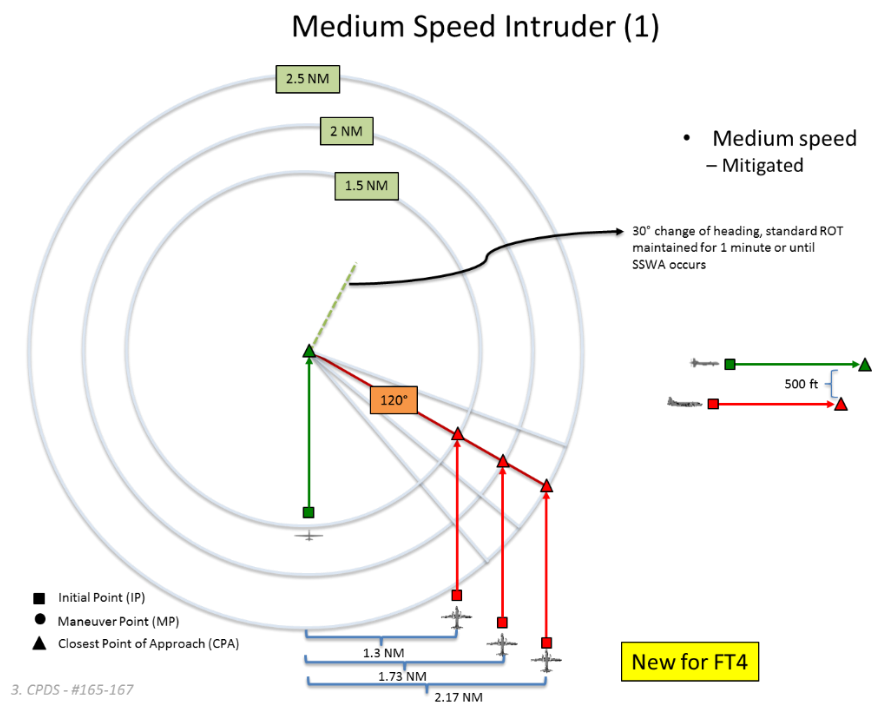


Figure 36. CPDS Medium Speed Intruder Encounters (1).

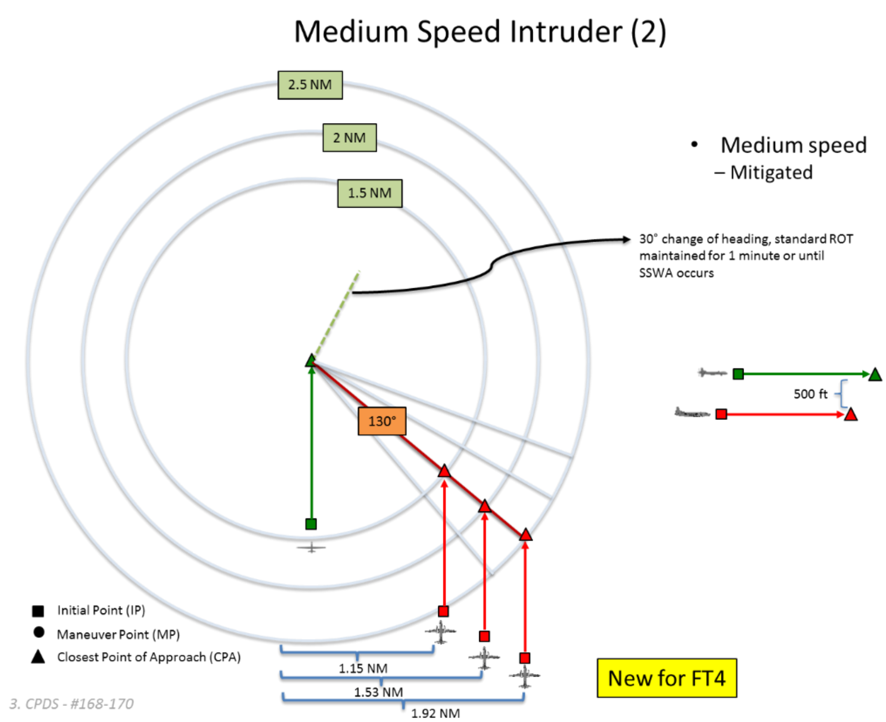


Figure 37. CPDS Medium Speed Intruder Encounters (2).

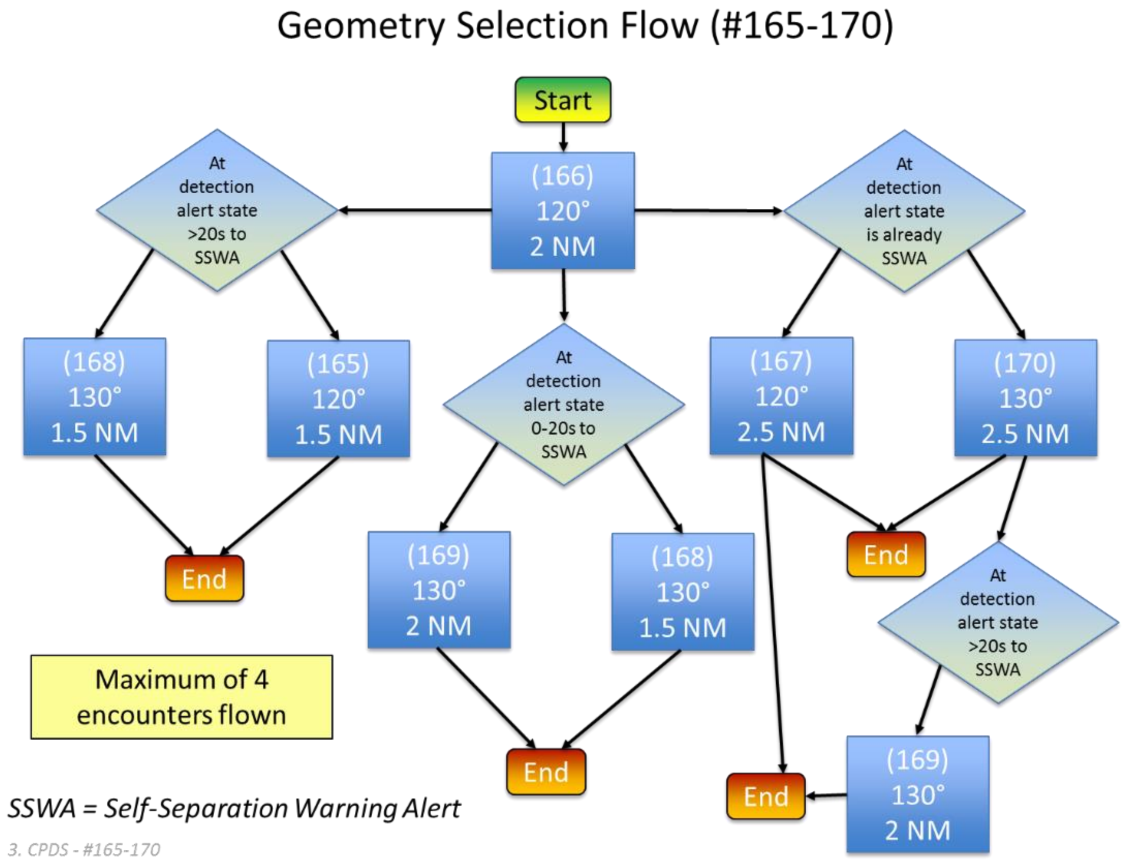


Figure 38. CPDS Medium Speed Intruder Encounters Flowdown.

The second type of encounter in FT4 for CPDS are multiship RA and DAA alerts encounters. The major goal of the second type of encounter is to gather data that can be used to analyze timeliness, correctness, and stability of DAA alerts and guidance that are suddenly triggered by an ownship collision avoidance maneuver. 'Suddenly' in this context implies that the time to predicted loss of well clear is at least within the CSSA threshold. These encounters have ownship receive alerting from a first intruder, then a second, essentially a 'sequential' multiship encounter.

In the first intruder encounter of the sequential encounter, a TCAS RA should serve as the trigger of the ownship collision avoidance maneuver (which leads to another DAA alert). In a geometry that is already stable before the collision avoidance alert threshold is reached, a DAA system will provide information about an upcoming loss of well clear. Hence, in such a situation the pilot would have to ignore the DAA alerts and guidance. To prevent confusion with the pilots (and be as close to a worst-case scenario as possible), it is not desired to have to brief pilots to ignore DAA alerts (that may persist for over a minute) of intruder 1 and 'wait' for a TCAS RA, while also having to explain that the DAA alerts and guidance for the second intruder are not to be ignored. To achieve this, conflict geometries are required in which the RA is not preceded by a significant time of DAA alerts. Hence, the primary intruder needs to maneuver such that the collision hazard geometry occurs at a time to CPA not much above 40 seconds.

This can be achieved by setting up a geometry in which either one or both of the conditions for the loss of well clear are not met until the time to CPA is so small that a maneuver is possible which reduces the predicted distance at CPA to within the alert boundary, without significantly reducing the time to CPA. To test the DAA algorithms both for level and climbing/descending intruders (important for the vertical velocity filters) two trigger geometries are needed for the first type of CPDS encounters:

1. The intruder first performs a blunder turn similar to the one performed in FT3 (with the result of DCPA decreasing to 0.5 nmi), followed by a descent (or climb) of the intruder which brings the predicted vertical separation at the horizontal CPA point to 200 ft.
2. The intruder is already at a conflicting altitude (i.e. within 300 ft) but the predicted horizontal miss distance is above the alerting threshold (i.e. > 1nmi).

The first trigger geometry is shown in Figure 39. Before the intruder 1 descent, the predicted horizontal separation has been reduced (due to the intruder turn) to within the TCAS RA limits. The descent will be the actual trigger for both DAA and TCAS. To minimize the duration of the DAA alert preceding the TCAS RA, the start of the descent will not be much sooner than about the TCAS tau for RA. The intruder will have the possibility to actually transition to a stable descent. The Descent Point (DP) is about 40 seconds before the horizontal CPA point. The descent will take place after ownship has completed the 45 degree change in heading.

Once the ownship has had the RA encounter with the first intruder, the second intruder will be in a position that the descent of ownship due to the RA will trigger a DAA alert. Two different situations are to be created, one in which the DAA alert is a CSSA (7.9 nmi initial lateral) and one in which the DAA alert is a SSWA (6.2 nmi initial lateral). Since SSWA is suppressed for TCAS-equipped intruders (in TARA mode), the second intruder should not have TCAS or at least not active in TA/RA mode.

With the second trigger geometry (Figure 40), the vertical speed of the intruder is zero at the moment the RA is triggered, i.e. the intruder is already at a conflicting altitude. Before the turn, the predicted horizontal miss distance is above the alerting threshold. To limit the time a DAA system will provide alerts and guidance before the TCAS RA occurs, the turn needs to be moved closer to the CPA point. The ownship descends, and then gets into a CSSA or SSWA alerting situation with intruder 2, just like in trigger geometry 1.

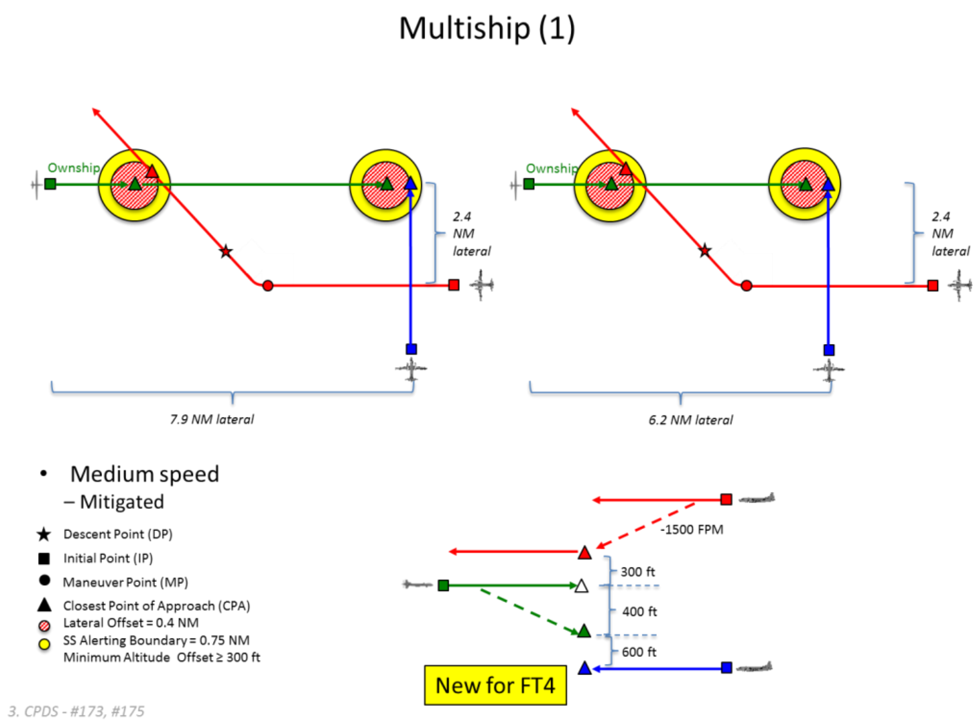


Figure 39. CPDS Multiship Intruder Encounters (1).

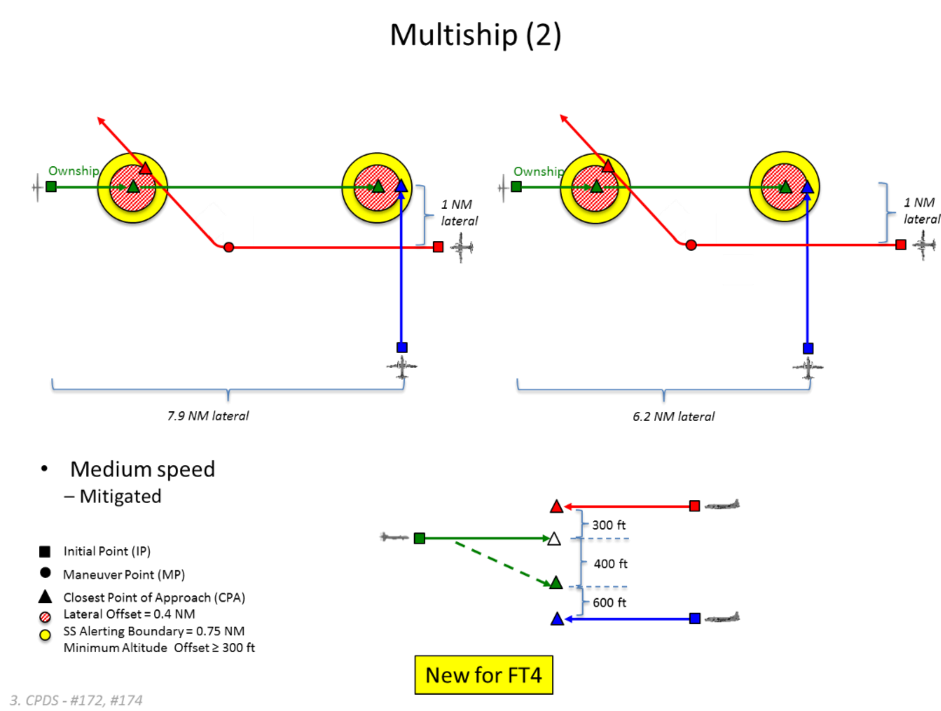


Figure 40. CPDS Multiship Intruder Encounters (2).

If for a certain target only TCAS data is available, and no estimates of velocity (groundspeed) and direction (track) are computed (tracker function), no DAA guidance can be provided. This will increase the likelihood that ownship pilot maneuvers in a direction that will cause an imminent loss of well clear, potentially followed by a TCAS RA. This type of encounter is most likely to occur if the TCAS-only target is in a low-closure rate geometry in which an ownship turn will cause an acceleration in time to CPA combined with a reduction in distance at CPA.

The final multiship CPDS geometry in Figure 41 is designed to get data on this type of encounter. To limit variability in the moment that ownship pilot responds to the DAA alert, the alert should not exist for the full CSSA warning time. This can be achieved by having intruder 1 turn within the CSSA alert time. In Figure 41 it is indicated that when intruder 1 comes out of the turn, time to CPA is 70 seconds. Intruder 1 is flying 300 ft higher than ownship.

Intruder 2 flies at a constant range and 120 degree bearing to ownship at an altitude of 500 ft below ownship.

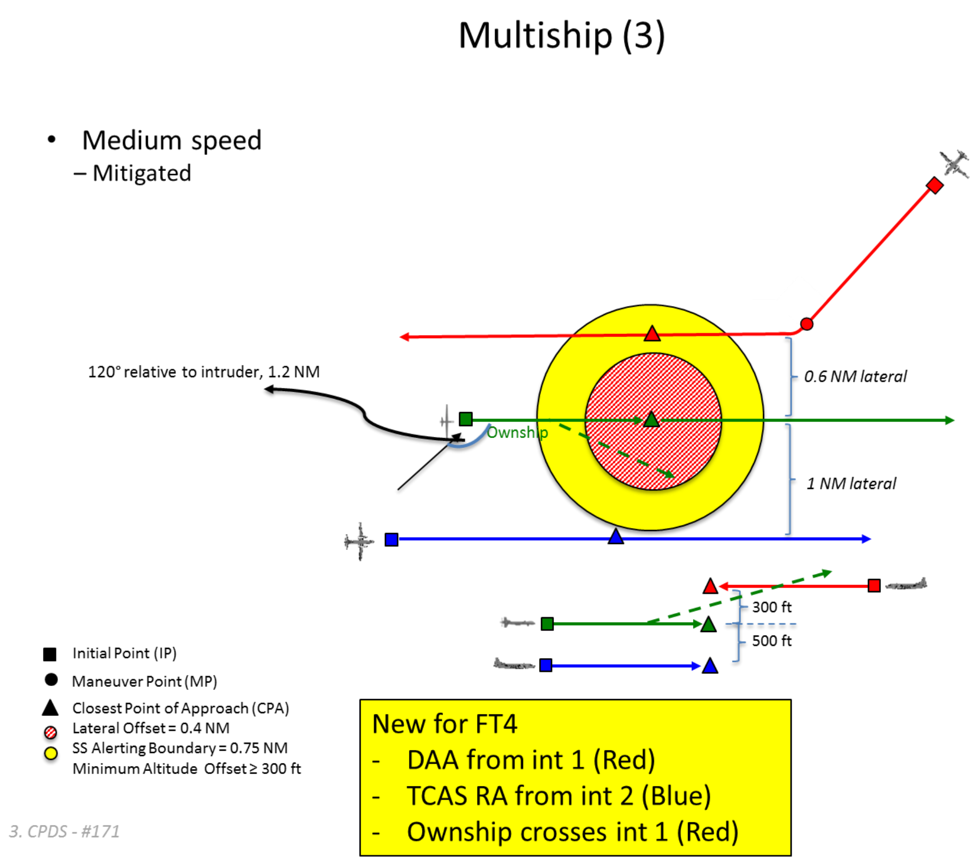


Figure 41. CPDS Multiship Intruder Encounters (3).

4.5.6.4 GA-ASI Encounter Geometry - Radar

Test encounter geometries provided by GA-ASI will collect data on the performance of the company provided EDM radar system and to help inform the SC-228 radar working group MOPS. To continue the research in operating at low altitudes from FT4, test encounters are planned at low altitude with ground clutter affecting target resolution. Figure 42 depicts the planned low altitude radar flight test geometries. The minimum test altitude will be 1,000 ft AGL based off the highest ground feature located along the flight path of the encounter. Both the ownship and the intruder will perform 1,000 ft AGL runs but at no time will an encounter participant operate below 1,000 ft. Ten low altitude radar runs are planned.

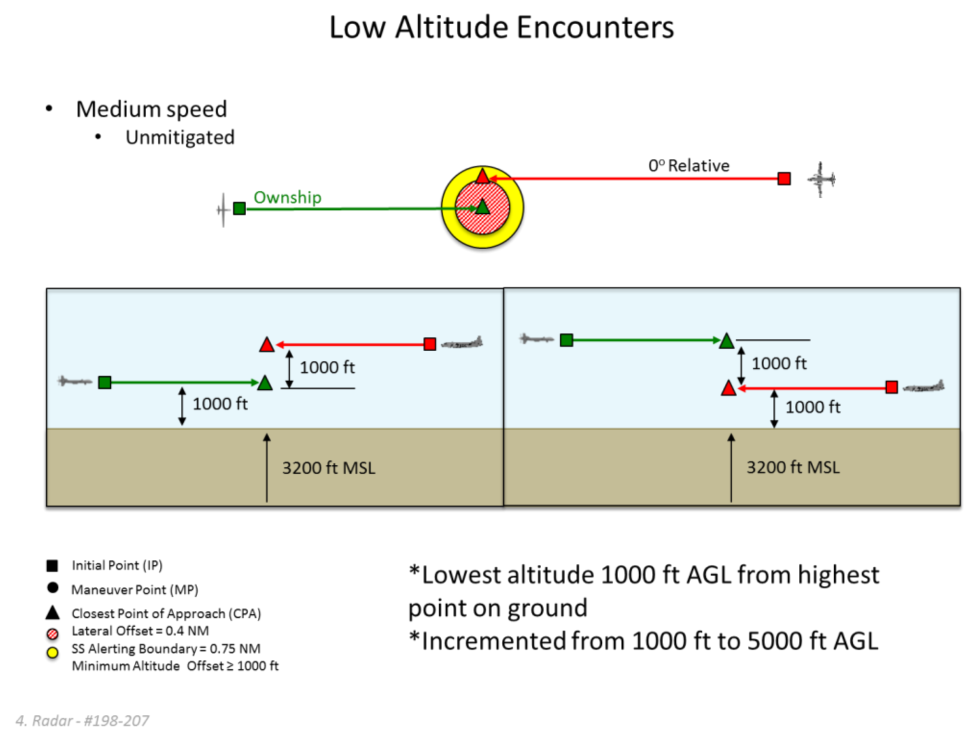


Figure 42. Radar Low Altitude Encounters.

Further, GA-ASI requires system performance with ownship overtaking (Figure 43), a small RCS, glider-type intruder (Figure 43), performance at various angles and initial distances, climbs, and descents (Figures 44-46), system performance of the radar during intruder ownship/intruder maneuvering (Figures 46-48), performance testing of the EDM radar to determine targeting capabilities at the azimuth limits of the radar (Figure 49) and performance with aircraft of various Radar Cross Sections (RCS) – small (TG-14), medium (T-34C), and large (Honeywell C90/King Air/GIII). A radar saturation encounter is also required for FT4 with 4 intruders. All intruders will be flying straight and level with 1000 ft vertical separation between each (Figure 50).

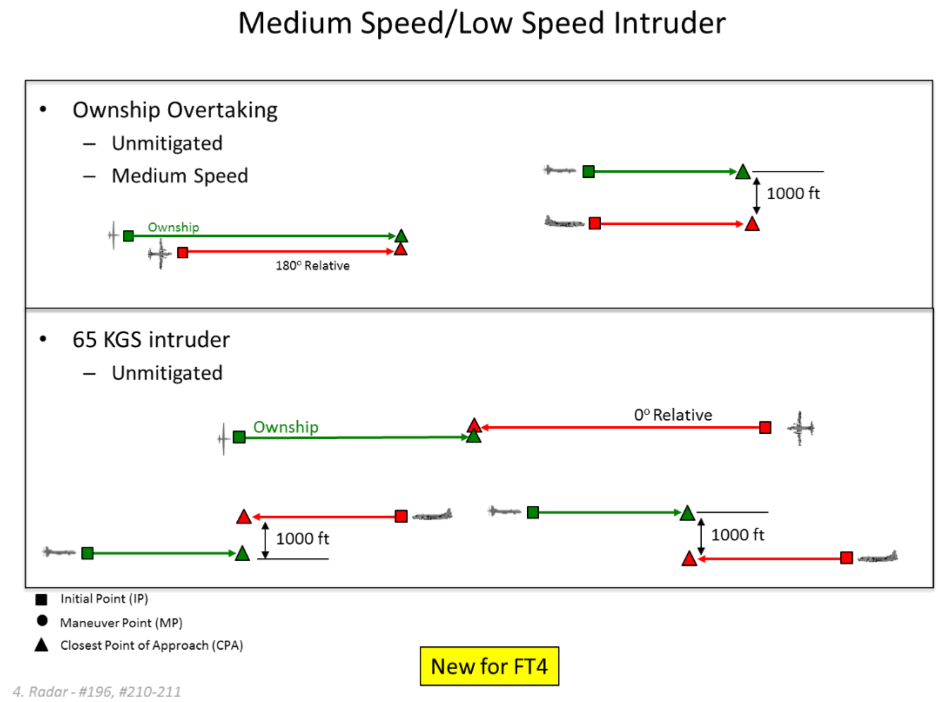


Figure 43. Radar Medium/Low Speed Intruder Encounters.

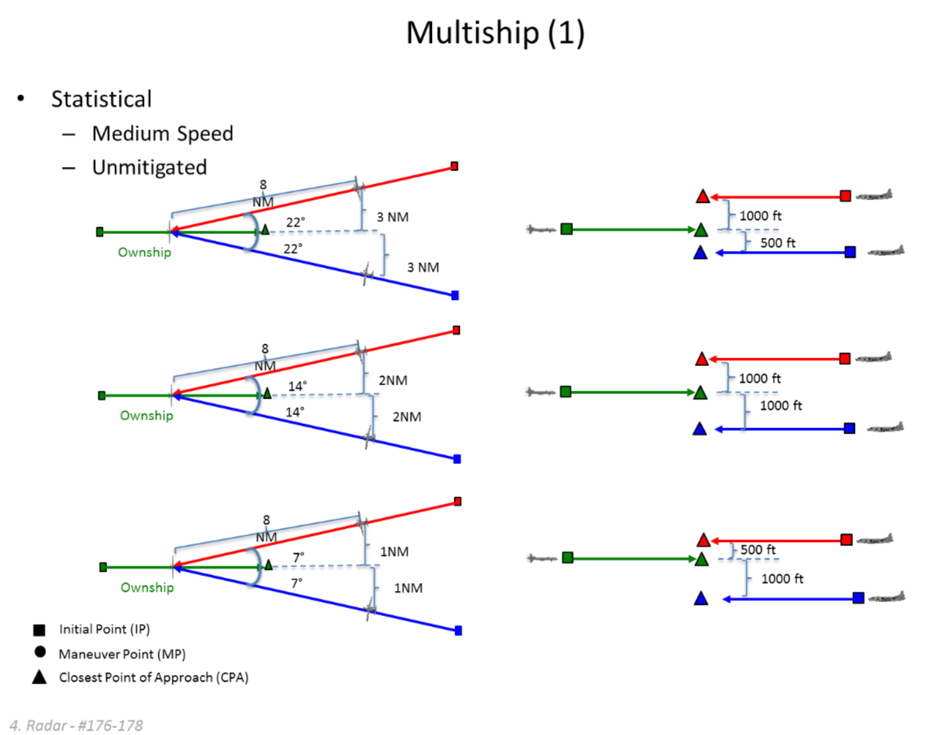


Figure 44. Radar Multiship Intruder Encounters (1).

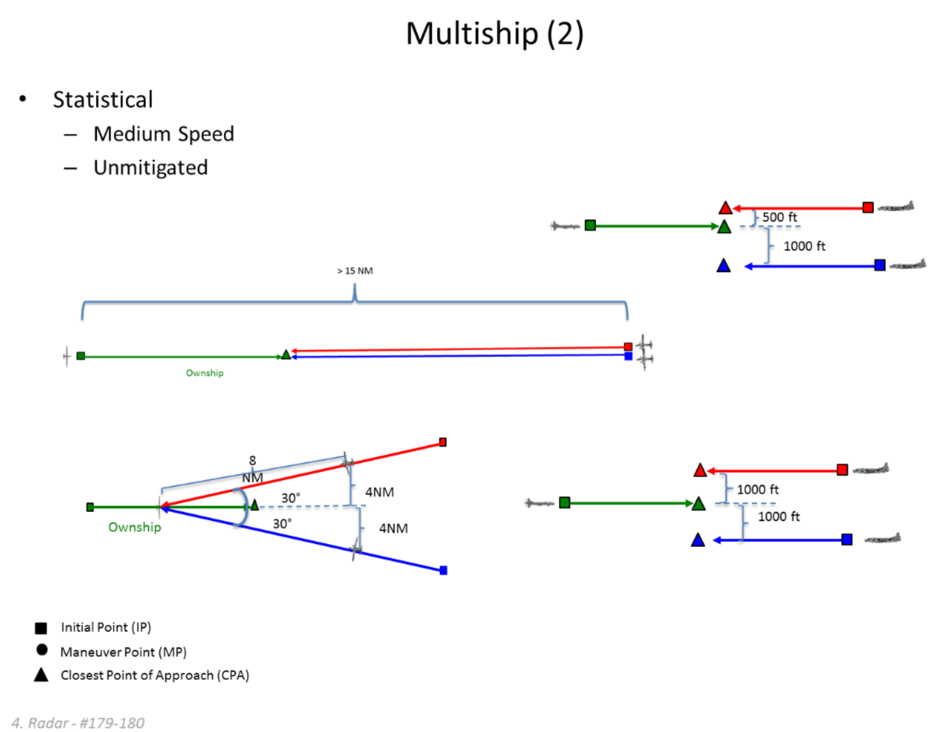


Figure 45. Radar Multiship Intruder Encounters (2).

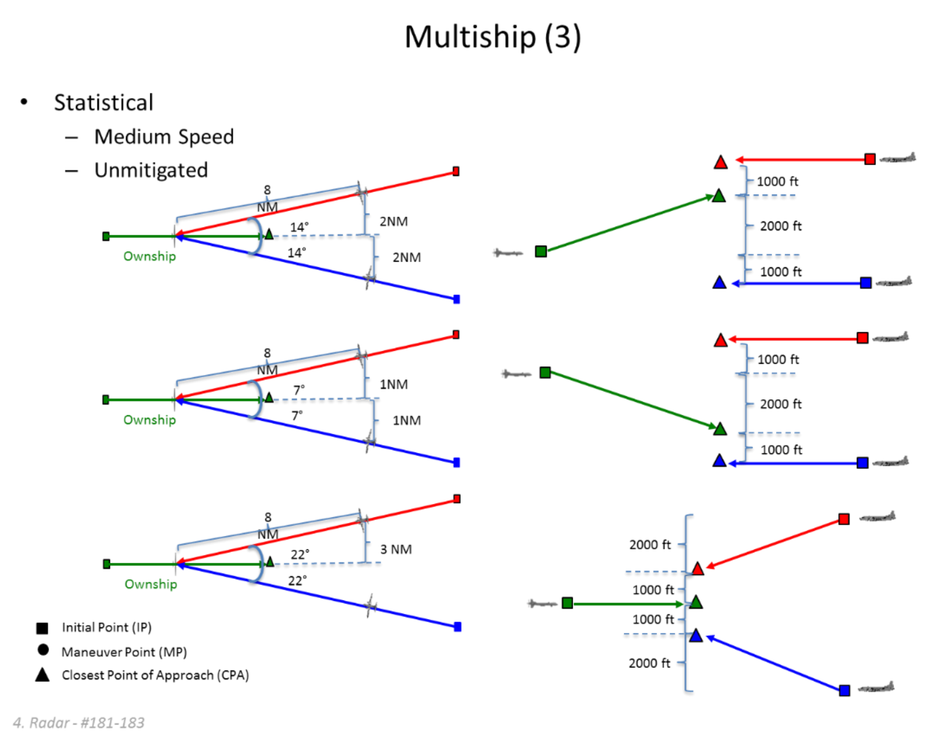


Figure 46. Radar Multiship Intruder Encounters (3).

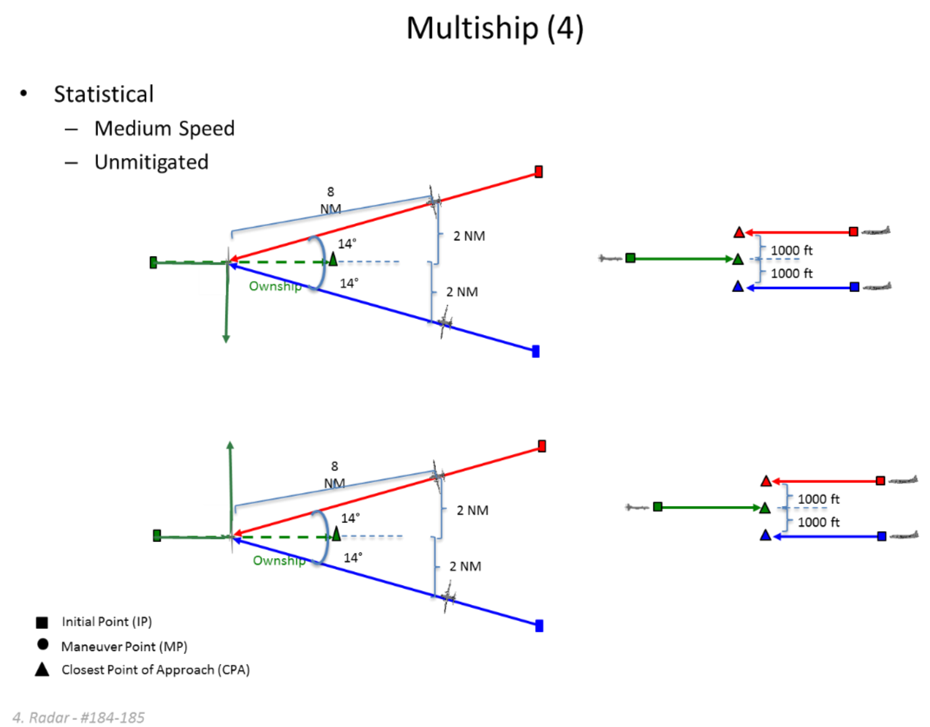


Figure 47. Radar Multiship Intruder Encounters (4).

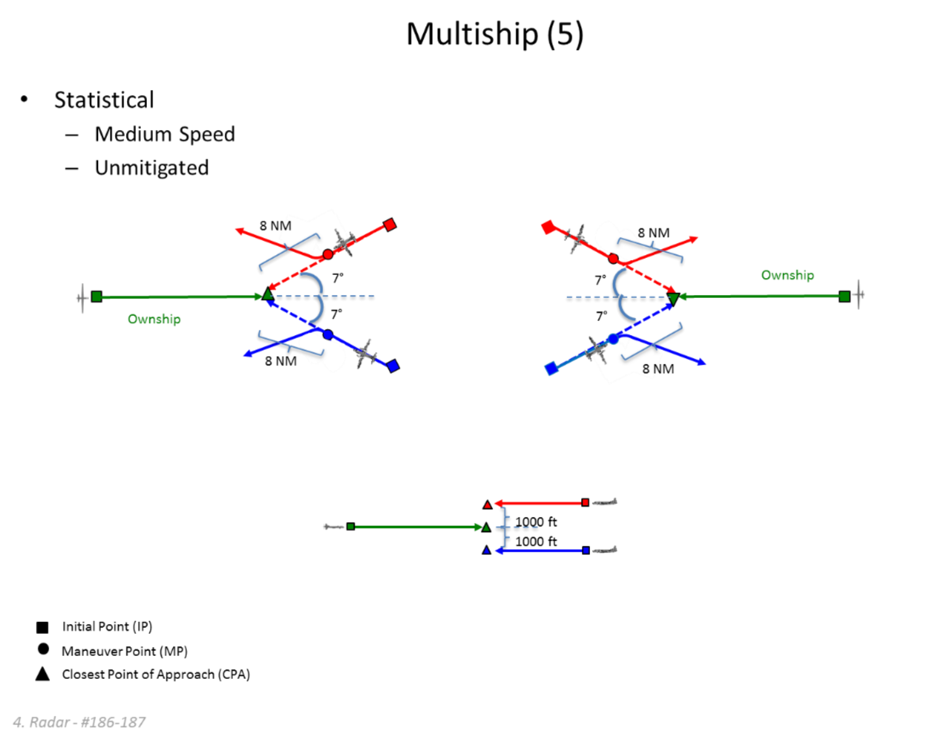


Figure 48. Radar Multiship Intruder Encounters (5).

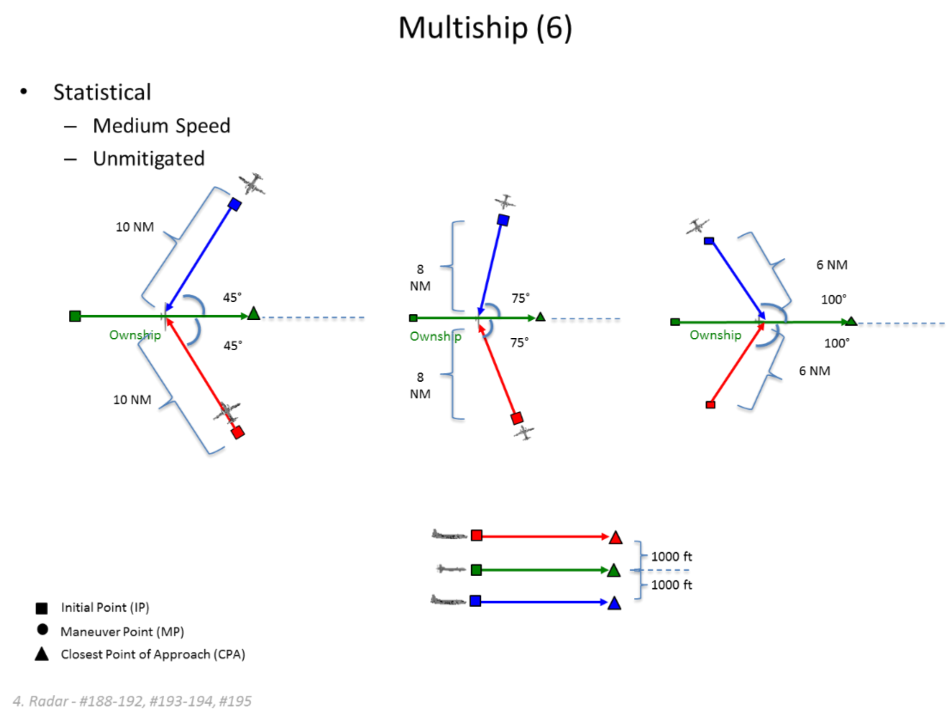


Figure 49. Radar Multiship Intruder Encounters (6).

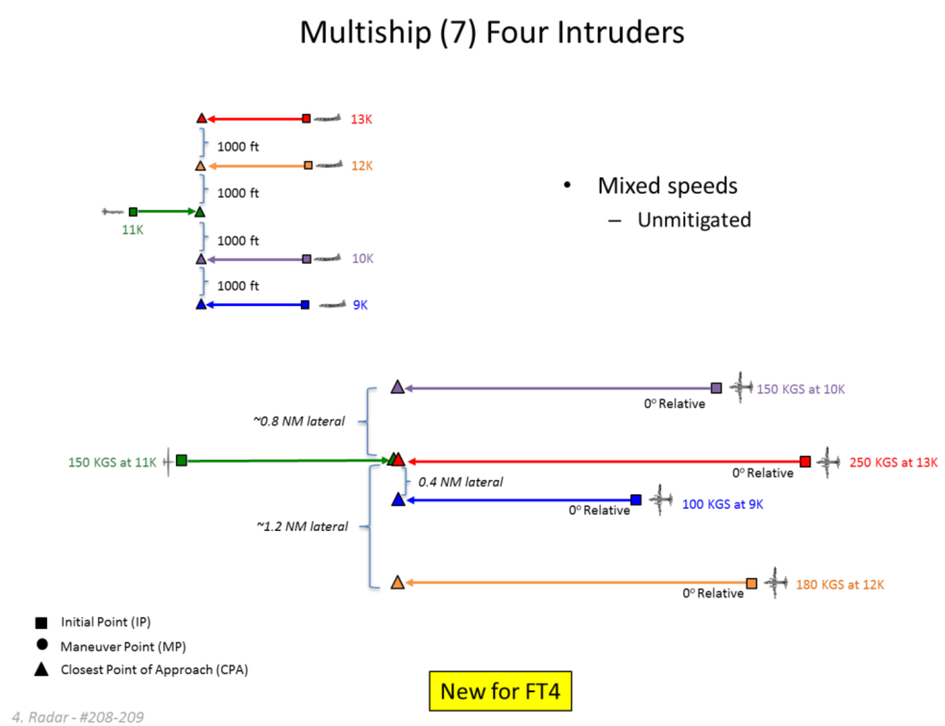


Figure 50. Radar Multiship Intruder Encounters (7) Four Intruders.

4.5.6.5 GA-ASI Encounter Geometry - TCAS

The CA performance encounters have been designed to test the full range of TCAS Resolution Advisories (i.e., preventive and corrective) and when executed automatically, to test the performance of the vehicle response in a real world environment. Climbing/descending ownship and intruders have been included to capture realistic encounter dynamics of the Phase I DAA MOPS definition of "transition". These encounters will also serve to capture Radar performance data all the way through a CA maneuver. Since the CPDS SS display will be running in the background during these CA encounters, researchers will have an opportunity to gather data on when TCAS RA affect SS algorithms and in what manner.

An encounter will test the RF shadow region of the TCAS directional antenna. This encounter is a simple fly-through data collection, and is shown in Figure 51.

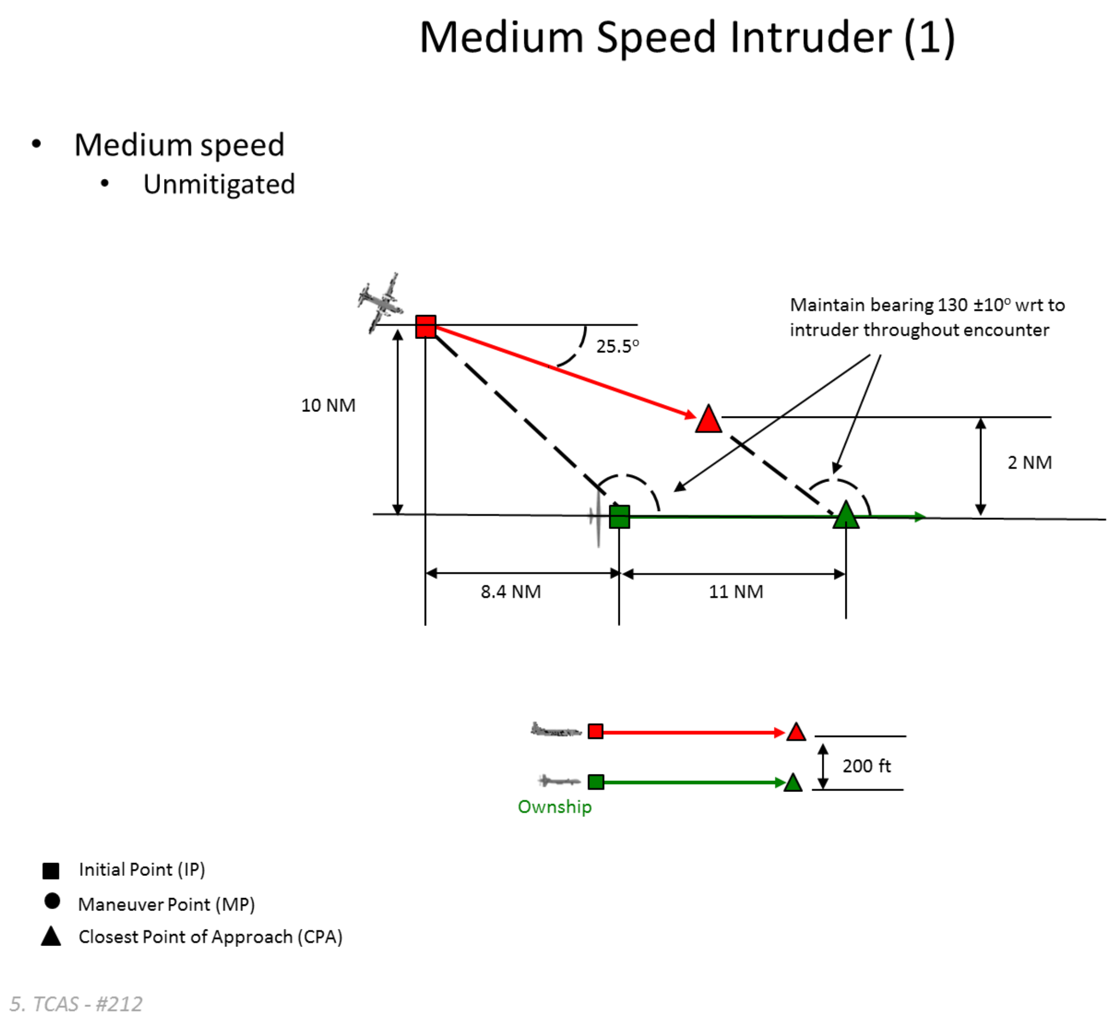


Figure 51. TCAS Medium Speed Intruder Encounters (1).

Additional encounters test the increased climb of TCAS version 1107.4 software. Figure 52 shows this encounter. The ownship pilot will experience a climb RA, followed by an increased climb RA, which will then be flown in advisory mode.

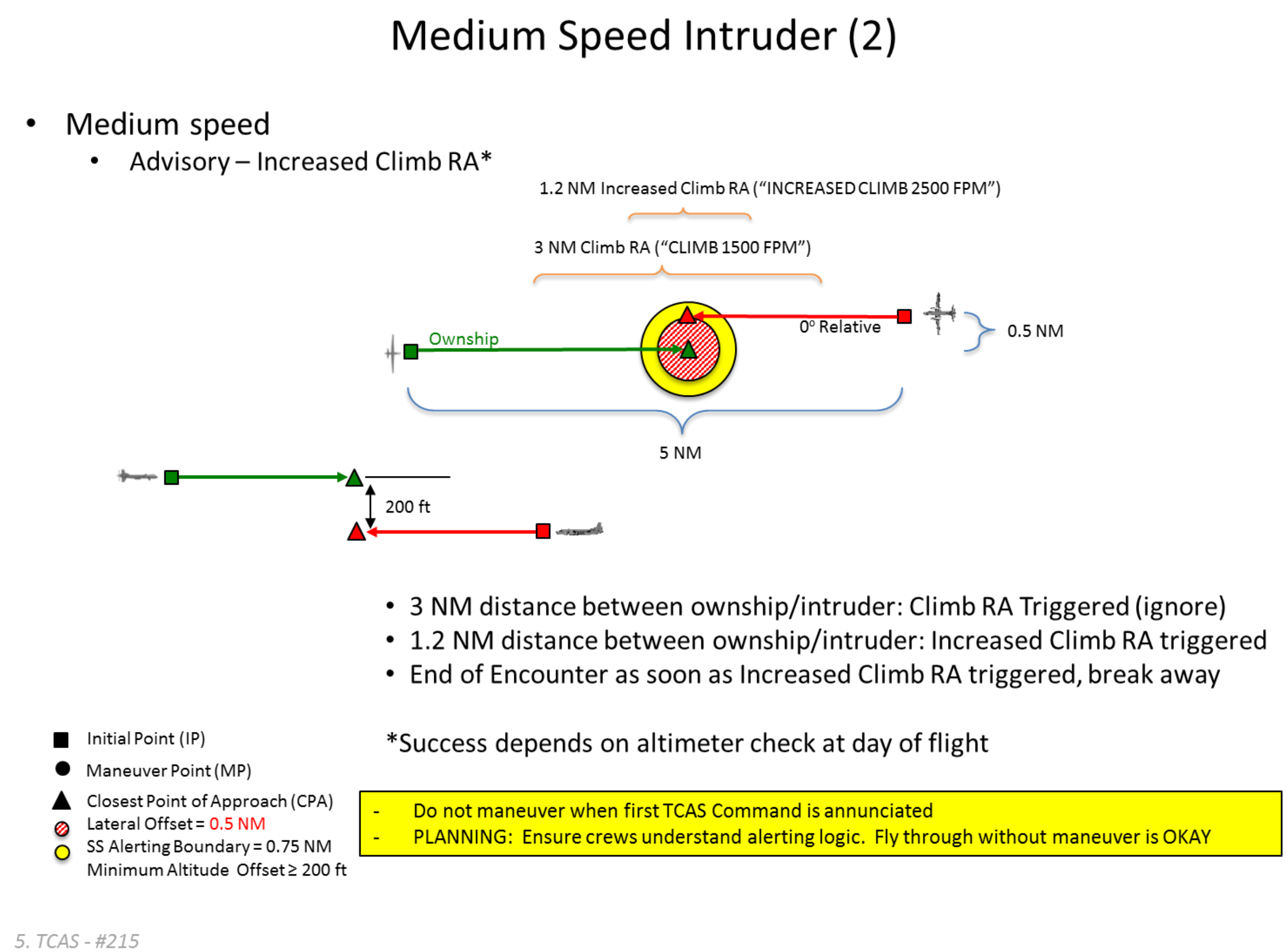


Figure 52. TCAS Medium Speed Intruder Encounters (2).

In addition, two encounters will be flown that trigger a "Do not descend >-500 fpm" RA and a "Do not descend >-1500 fpm". These encounters are depicted in Figure 53. Intruder will climb at a specific rate from a specified vertical distance and timing from ownship. This will cause the desired warning.

Medium Speed Intruder (3)

- Medium speed
  - Advisory – Do not descend -500 fpm/-1500 fpm

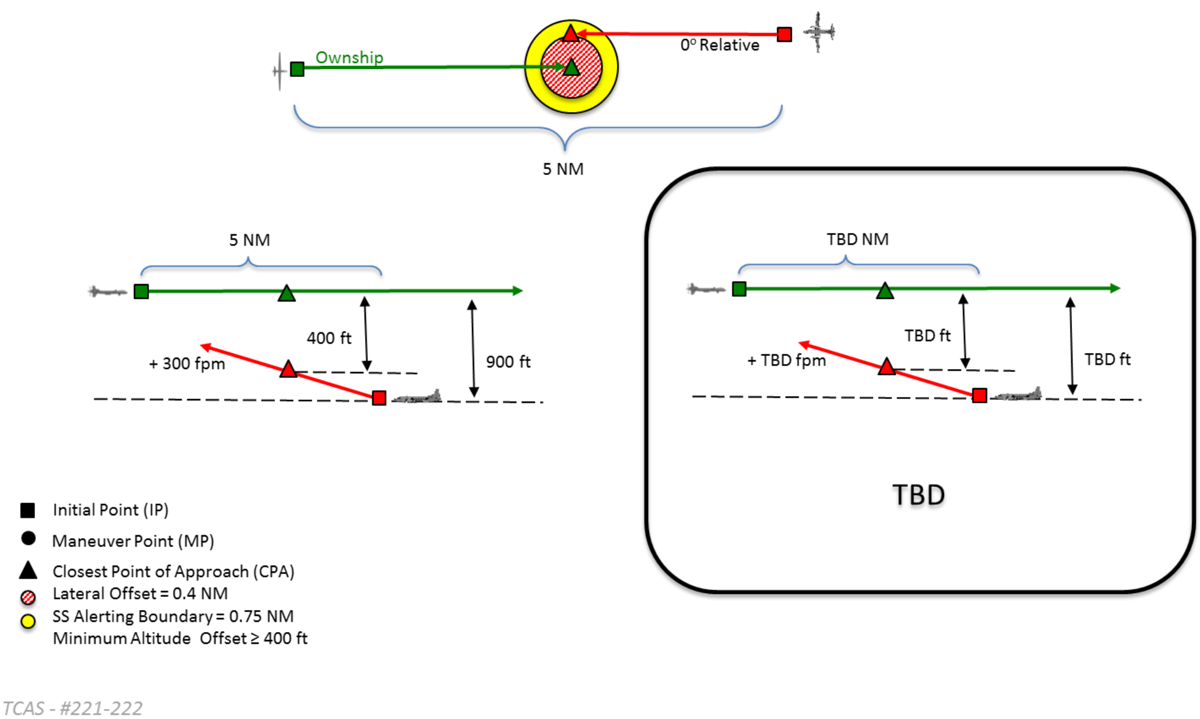


Figure 53. TCAS Medium Speed Intruder Encounters (3).

Similar to FT3, the stakeholder will require a TCAS sequential warning encounters that involve two intruders. These encounters are depicted in Figures 54 and 55. The first encounter will trigger a "Climb" RA from first intruder and a "Do Not Climb" RA from the second intruder. The second encounter is reversed, and will trigger a "Descend" RA from the first intruder and a "Do Not Descend" RA from the second intruder. These encounters will be flown in advisory and then AUTO mode.

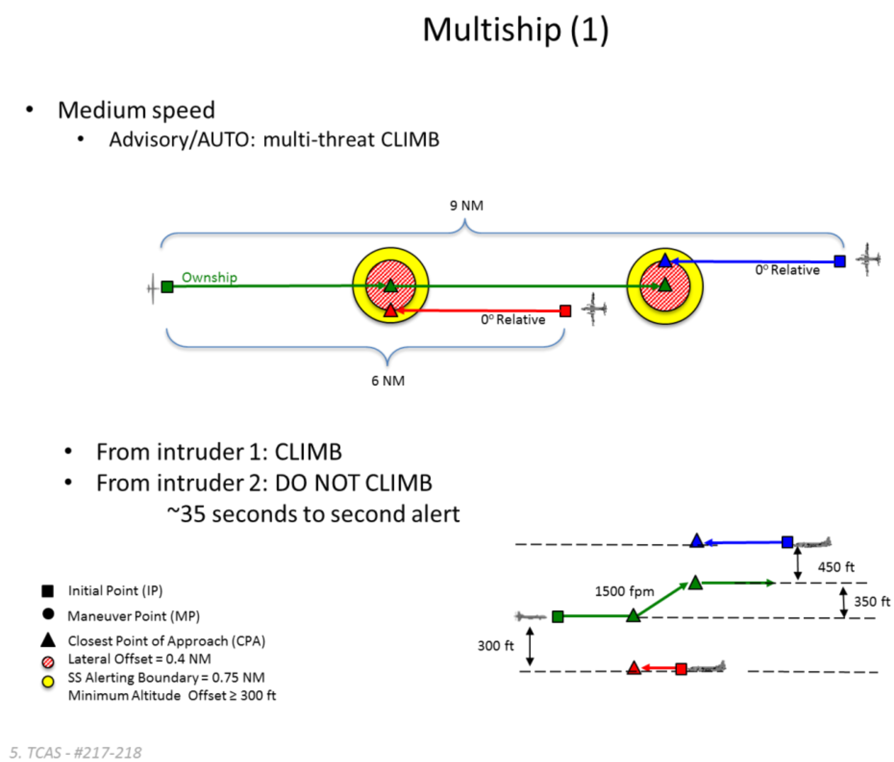


Figure 54. TCAS Multiship Intruder Encounters (1).

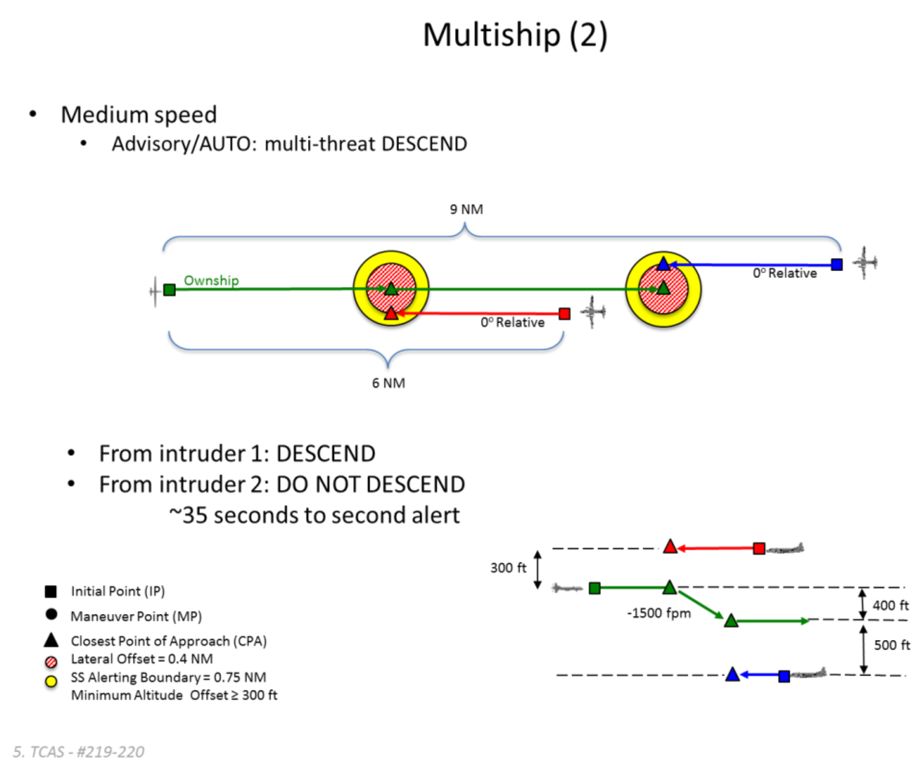


Figure 55. TCAS Multiship Intruder Encounters (2).

4.5.6.6 Honeywell Encounter Geometry

To test the full capabilities of the Honeywell Fusion Tracker, Honeywell has provided various geometries in stressing the tracker using the full sensor selection suite.

The first set, shown in Figure 56, has ownship overtaking intruder and intruder performing pitch steps at various climb/descent rates: +/- 500 ft/min, +/- 1000 ft/min, +/- 1500 ft/min, +/- 2000 ft/min. The purpose for these encounters is to test the vertical rate estimation for various vertical rates of the tracker.

The second set, also in Figure 56, has ownship and intruder both performing accelerating “zig-zag” standard turn rate maneuvers toward one another at various altitudes. Both ownship and intruder turn in the same direction. These encounters will test the tracking of an accelerating intruder.

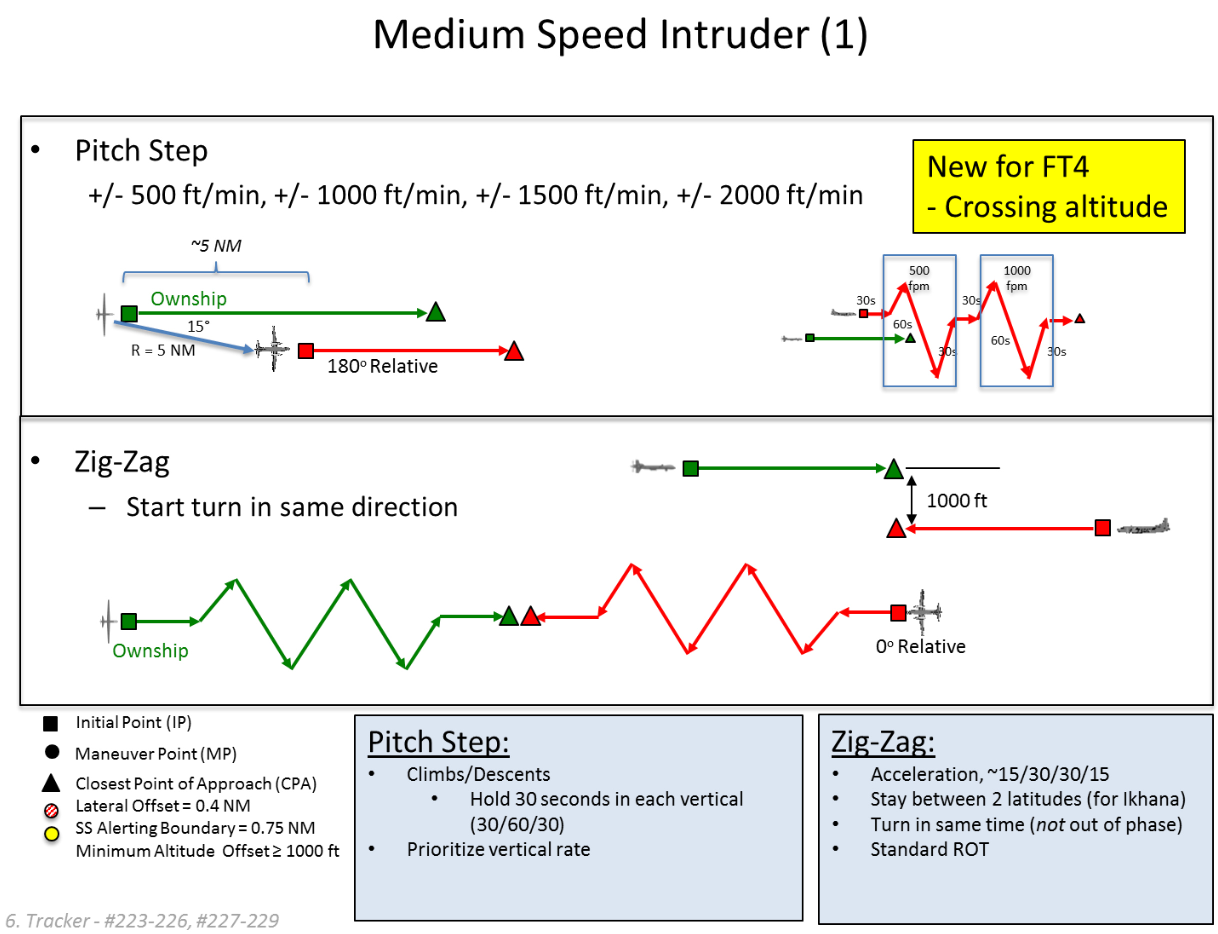


Figure 56. Honeywell Medium Speed Intruder Encounters (1).

Figure 57 is a new for FT4 and requires the intruder to climb and maneuver or descend and maneuver, towards the straight and level ownship, at the same time. The tracking of an intruder in multiple dimensions will be tested. These encounters are set to have CPA at 5 nmi, at which point the intruder begins to maneuver away and climb or descend at 2000 fpm.

Figure 58 has the ownship and intruder reverse roles, with the ownship performing the maneuver and climb or descent at 1000 fpm. The purpose is to test the tracking of an intruder while ownship is performing maneuvers in multiple dimensions.

The final set of encounters in Figure 59 requires ownship to maneuver and intruder to climb (2000 fpm), or intruder to maneuver and ownship to climb (1000 fpm). As in the previous set, the CPA will be at 5 nmi. This is another case of testing tracking in multiple dimensions.

All Honeywell encounters will be tested at various altitudes to assess the tracker performance at the change of altitude.

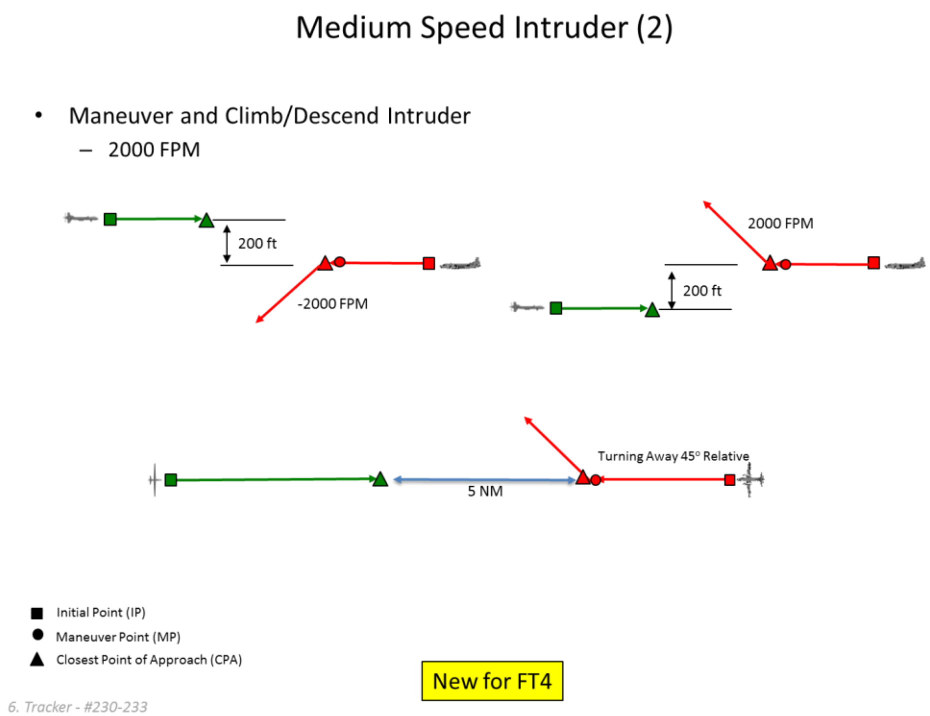


Figure 57. Honeywell Medium Speed Intruder Encounters (2).

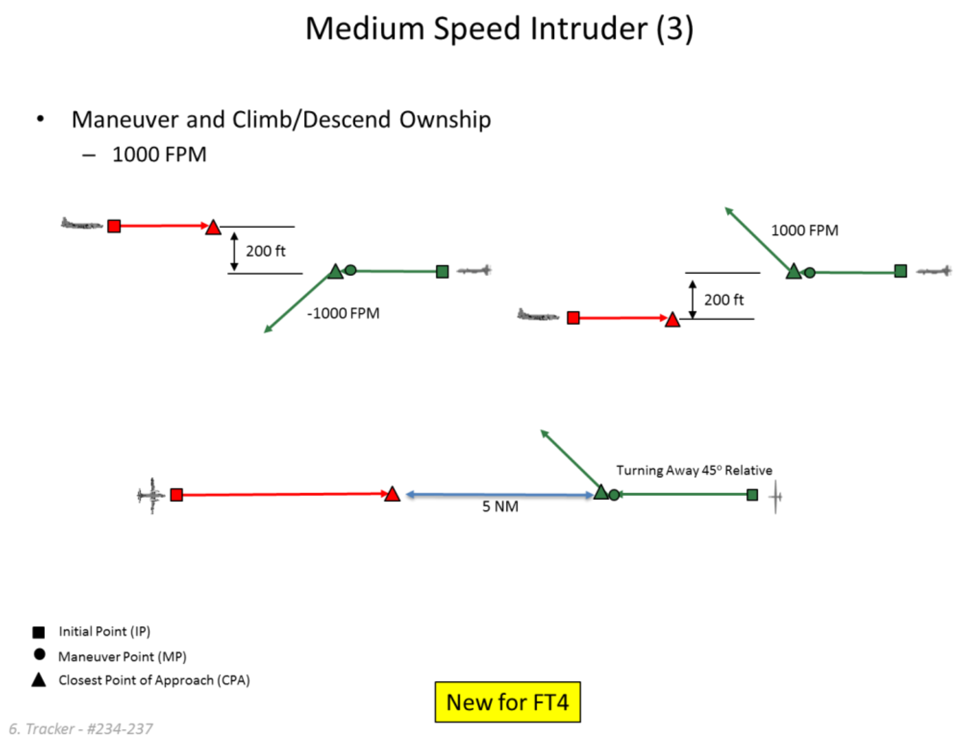


Figure 58. Honeywell Medium Speed Intruder Encounters (3).

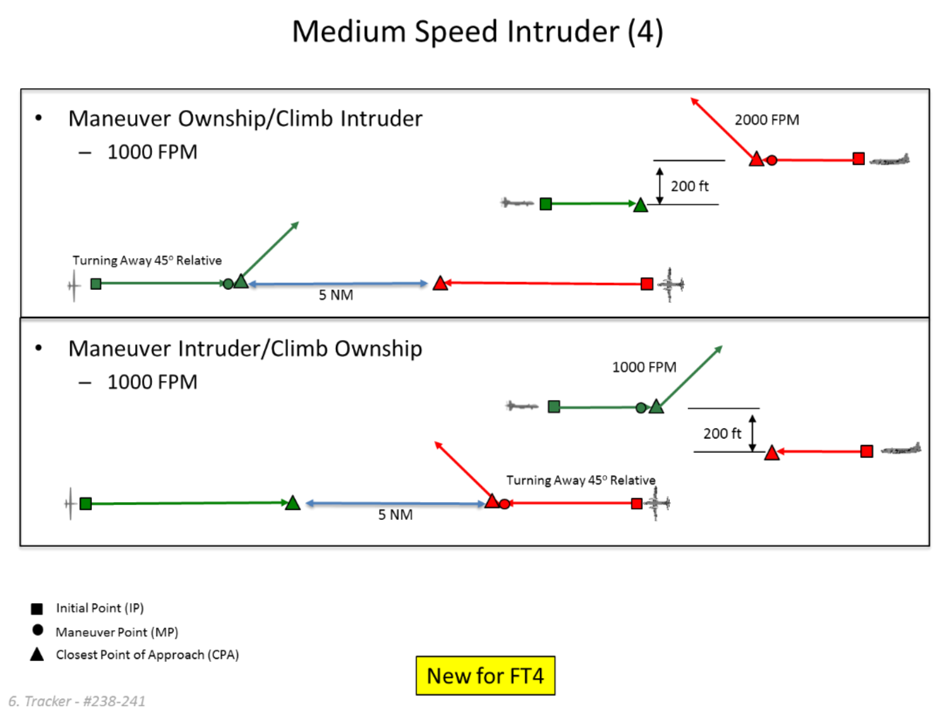


Figure 59. Honeywell Medium Speed Intruder Encounters (4).

4.5.6.7 SC-228 Encounter Geometry

A new stakeholder for FT4, SC-228 V&V Subcommittee are interested in: collecting overall DAA system and subsystems performance and interface data to validate DAA MOPS requirements, collecting radar system performance and interface data to validate Radar MOPS requirements, and collecting data to validate simulation models used for MOPS validation.

For this reason, the SC-228 V&V Subcommittee will not only collect data from the previous described encounters, but they will require encounters not performed by the previous researchers' objectives using the three DAA algorithms for their test encounters.

Many of these encounter types, although not complex, have not been flown before for UAS in the NAS. The SC-228 encounters will include a large variety of sensor combinations, flight altitudes, maneuvers, speeds, and a unique mode C only intruder mentioned previously. For a few of their encounters, the intruder will even need to turn off its transponder to represent a radar-only target. Additional details on the test objectives for each encounter can be found in Appendix F.

As the other researchers, SC-228 will require a high-speed intruder for some encounters, shown in Figure 60. The high speed encounters are a simple geometry and 1v1.

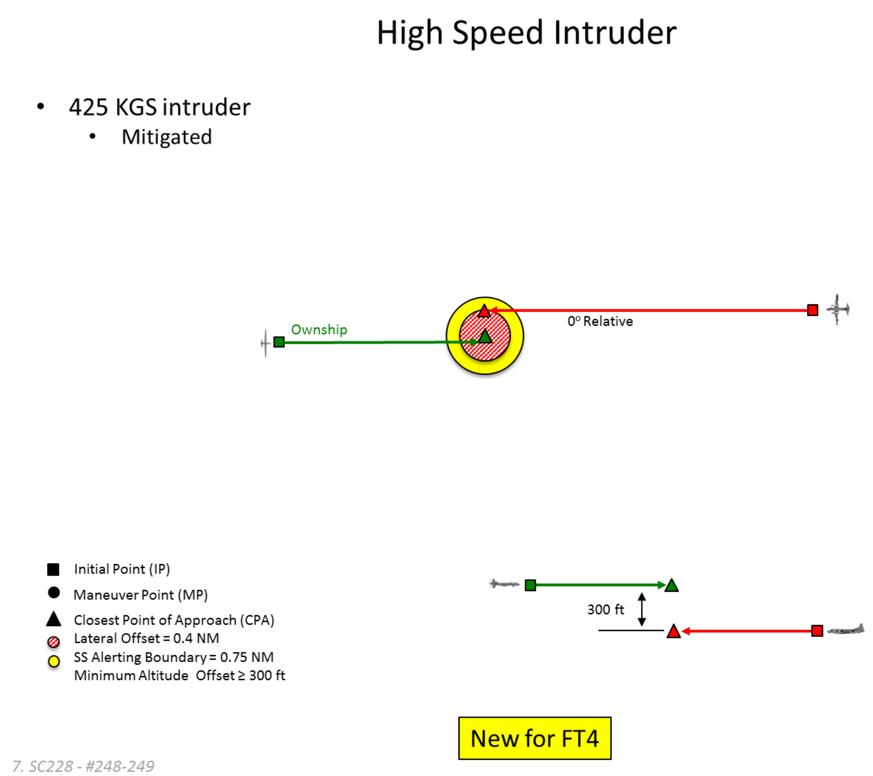


Figure 60. SC-228 High Speed Intruder Encounters.

A low speed intruder will also be utilized, depicted in Figure 61. The two types of encounters shown in the figure have not been flown before. First, a maneuvering low speed intruder encounter will be flown, with the intruder turning 90° to a final CPA in front of the ownship. A second type of low speed intruder encounter will simulate a loitering maneuver by intruder.

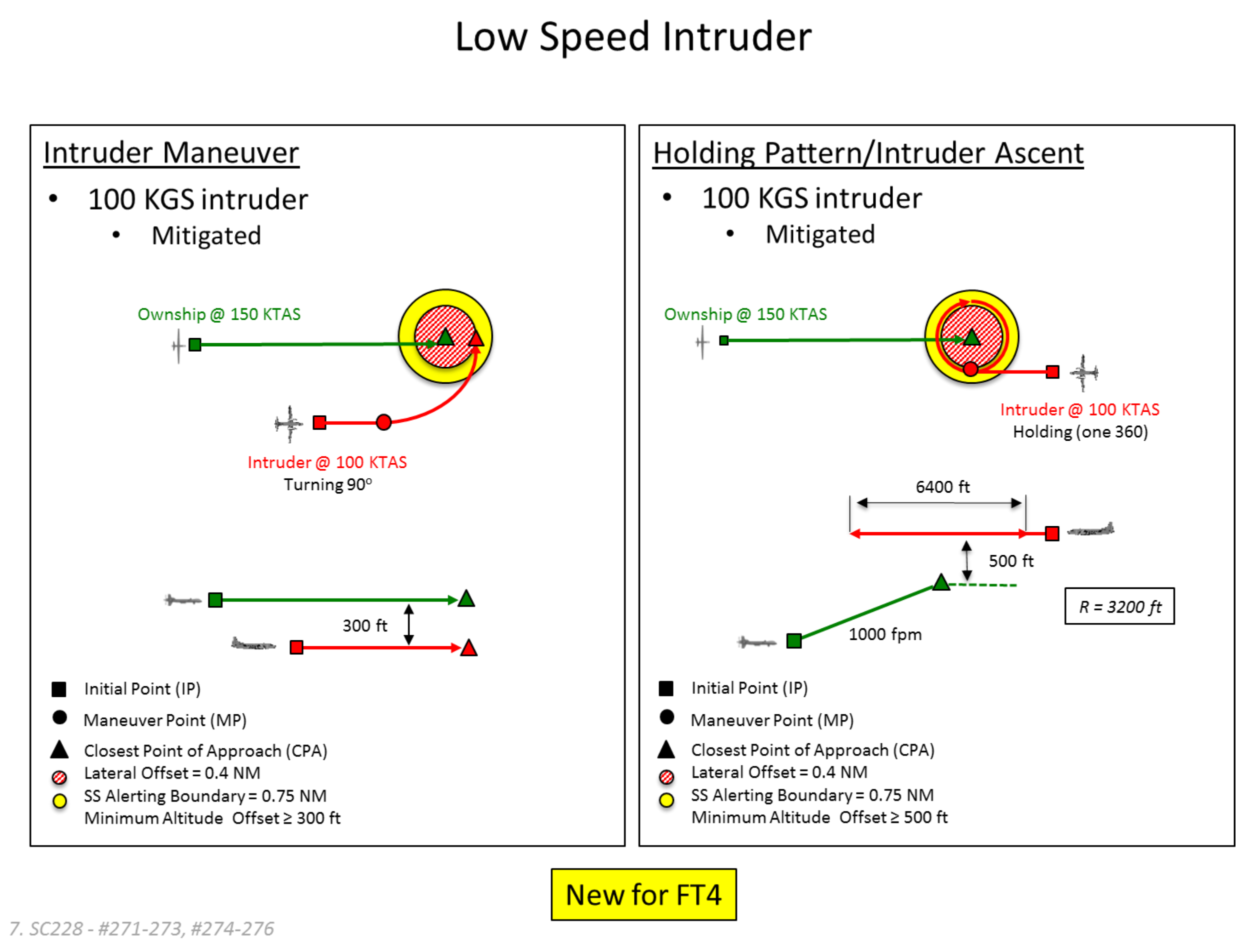


Figure 61. SC-228 Low Speed Intruder Encounters.

Figure 62 depicts the first set of medium speed intruder encounters. The group on the left will be flown with the mode C only intruder, as a TCAS RA target for interoperability, and for WCR. On the right is a similar maneuver performed during FT3, with ownship only climbing to intruder.

Figure 63 shows an ownship overtaking encounter whilst descending simultaneously. On the right is a double blunder encounter, similar to what was flown during FT3.

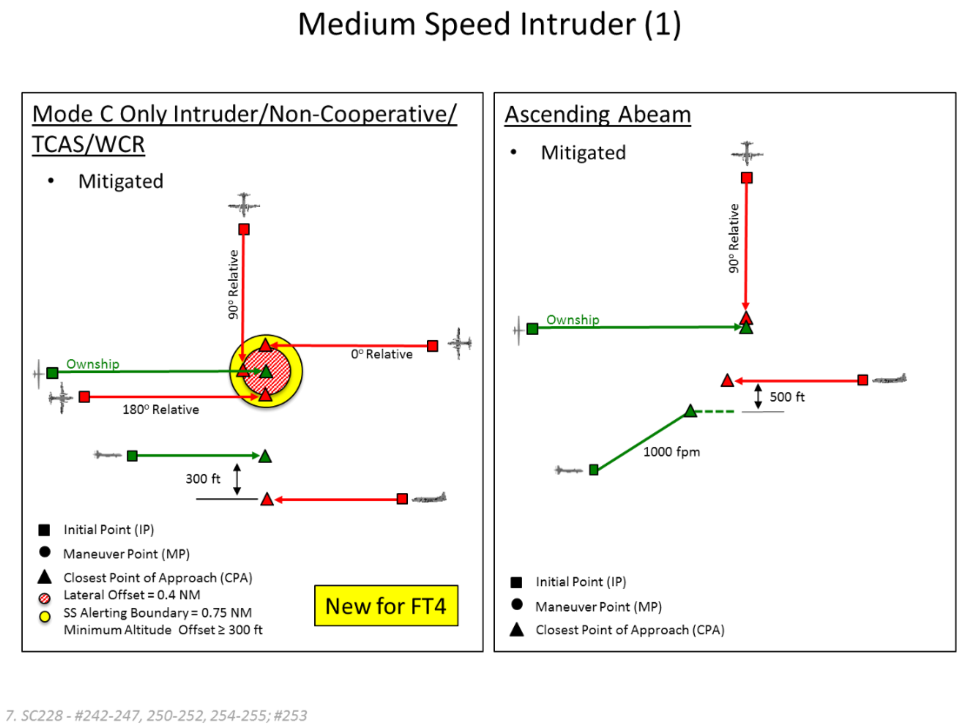


Figure 62. SC-228 Medium Speed Intruder Encounters (1).

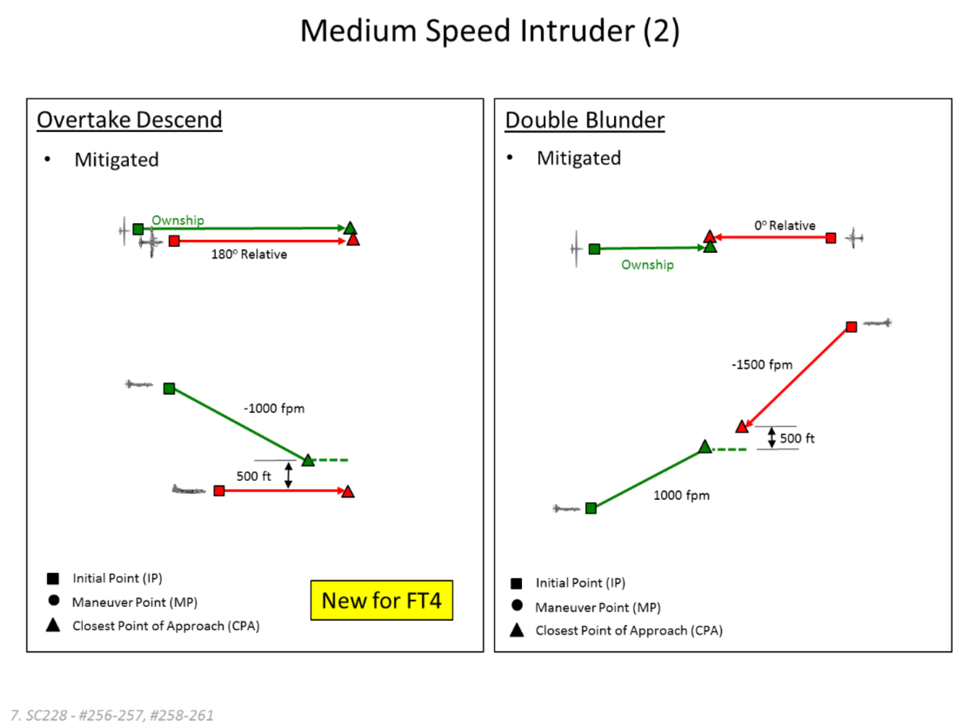


Figure 63. SC-228 Medium Speed Intruder Encounters (2).

Figure 64 shows an intruder maneuvering encounter on the left, with a slight difference than what was flown for other stakeholders: the intruder's predicted CPA is expected to be on the side of ownship CPA. This encounter is designed to test the limits of the DAA algorithms' predictive capability. The encounter on the right is also a double blunder, but again, with a difference: the expected predicted CPA is set to alert at 1000 ft separation, at which point the intruder will level off. This tests the outer limits of the DAA alerting boundaries.

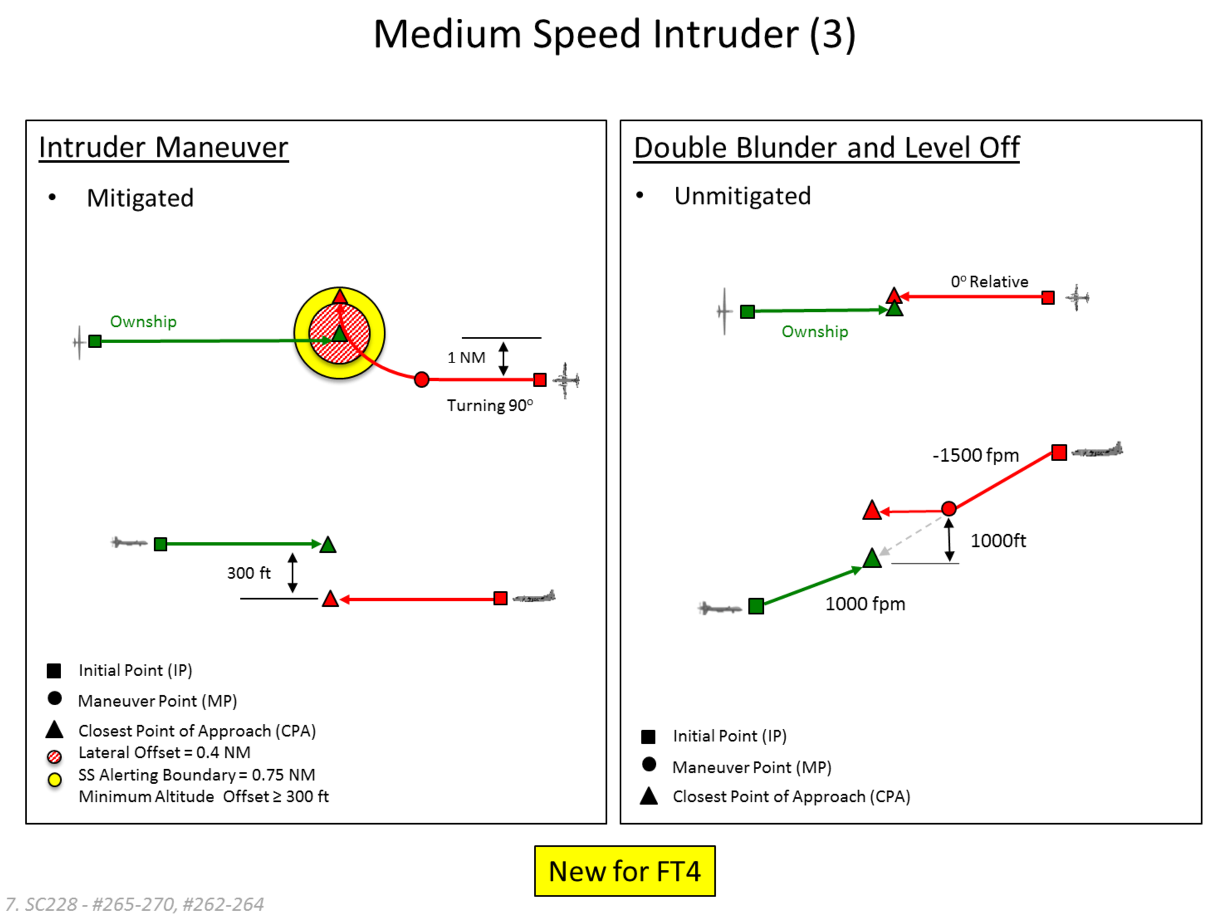


Figure 64. SC-228 Medium Speed Intruder Encounters (3).

Figure 65 left is an ownship turn and climb. Although Honeywell has a similar encounter, this is the first time an ownship hybrid maneuver will be performed to test the DAA algorithm. The blunder on the left is similar to the double blunder shown in Figure 64, expect with ownship flying level for this type of encounter.

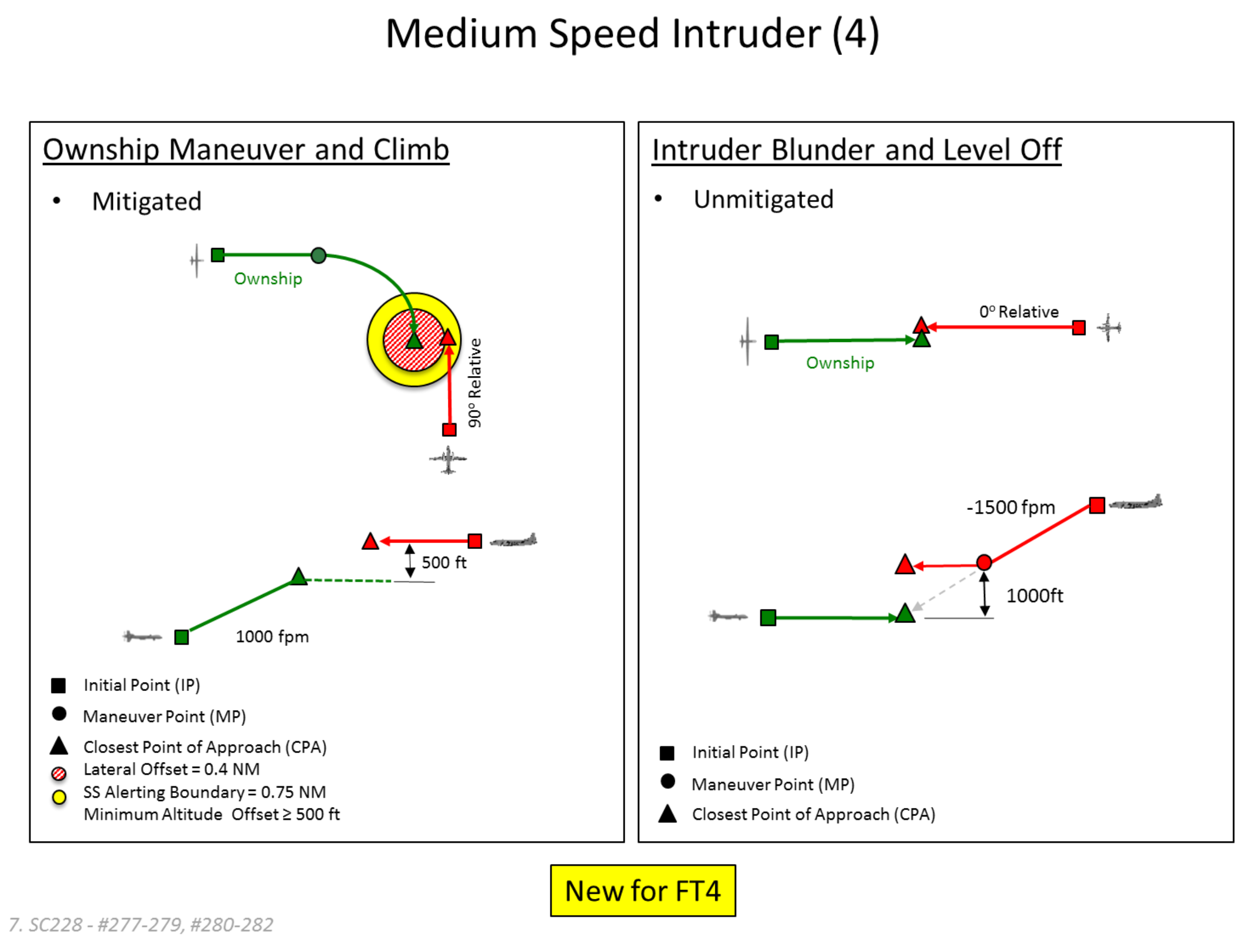


Figure 65. SC-228 Medium Speed Intruder Encounters (4).

SC-228 also has a set of multiship encounters. The first set, shown in Figure 66, is divided into Blocking Type 1 and Blocking Type 2. Blocking Type 1 has the two intruders flying co-altitude but staggered towards ownship. Blocking Type 2 has the two intruder flying the same latitude line, but again, staggered and separated by a large altitude block. Some of these encounters include a radar-only target (no transponder).

Figure 67 shows the second set of multiship encounters, Blocking Type 3 with a low and medium speed intruder. Intruder 1 (red), either a low-speed or medium-speed intruder, blocks ownship in the horizontal direction and is being overtaken by ownship. The second intruder flies on the other side of the alerting volume with a large altitude offset. Again, a selection of these encounters have a radar-only target.

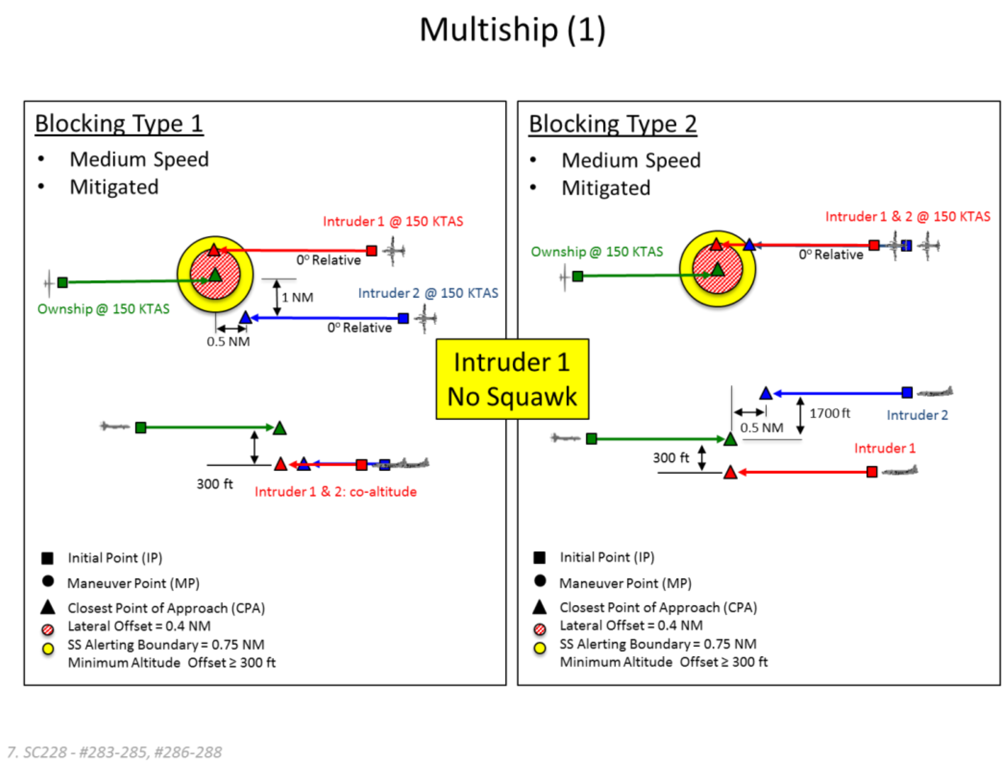


Figure 66. SC-228 Multship Intruder Encounters (1).

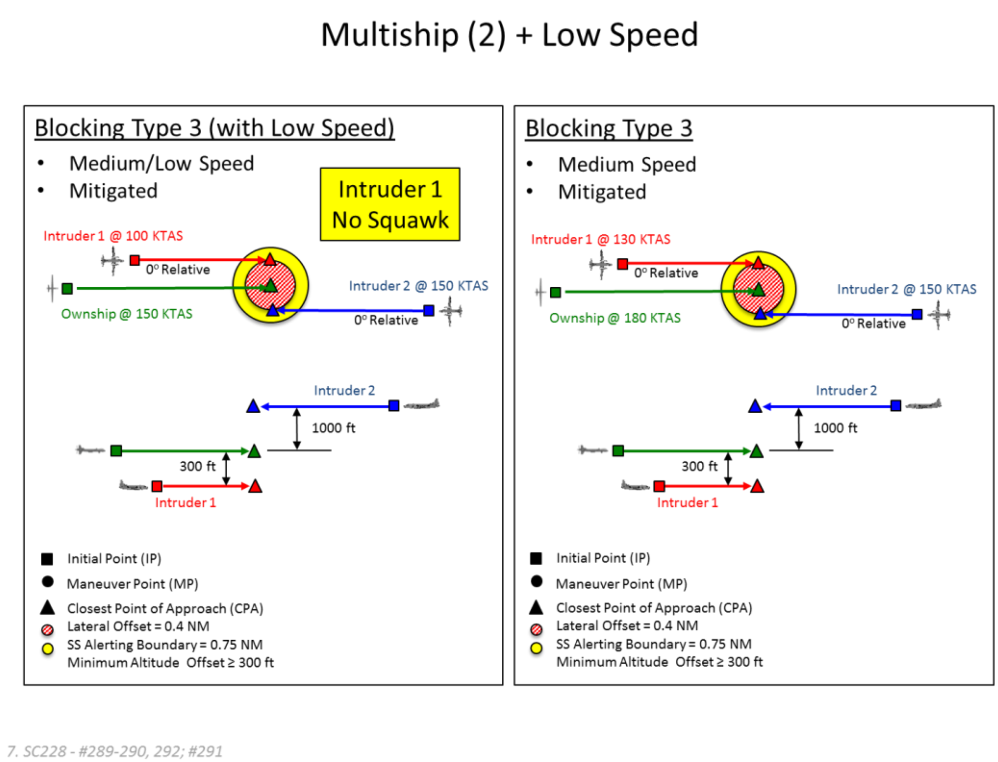


Figure 67. SC-228 Multship Intruder Encounters (2).

4.5.7 Minimum Success Criteria

Success criteria for specific test encounters are captured in the test objective templates located in Appendix F.

5 Test Reporting

Several reports shall be developed by specific members of the test team and distributed as described in this section.

5.1 Deficiency Report

During testing any deficiencies that are found in the system or any component of the system will be reported to the Test Conductor. The circumstance of the testing during the deficiency will be noted. At the discretion of the Test Conductor the test may continue, or be terminated. During the Post-test Brief, any deficiency reports will be reviewed. The Test Conductor and Project Engineers will determine whether any steps need to be taken to mitigate the deficiency before continuing with the next set of tests

5.2 Progress Report

The IT&E sub-project will deliver preliminary test results to the UAS-NAS Project Office during testing on a per request basis. After each debrief, the AFRC IT&E PE will compile and submit a daily test run sheet to the Project Office including runs/events planned versus successfully accomplished on that day, a summary of deficiencies identified during the day, and a brief statement of the next test period/day's planned runs.

5.3 Flight Test Report

After completion of Flight Test 4, the IT&E Ops team will develop a report that details the flight test execution, results and lessons learned to be submitted to the UAS-NAS Project Office. The final report will be processed through the NASA AFRC Export Control office and become a public releasable document.

6 Data Collection

The Flight Test 4 Data Management Plan, IT&E DMP-001, is the reference source for the following data management activities required for FT4:

- Purpose of data collection;
- Sources and types of data to be collected by each flight test participant;
- Quick-Look at data on day-of-flight;
- Reception and archival in a central data repository; and
- Providing data from the central data repository to test participants.

Each participating organization captures data relevant to the FT4 flights received by its aircraft or generated by that aircraft, including surveillance and tracking data (both ownship and other aircraft), inter-aircraft data communications, air-ground data communications, as well as data provided to and actions produced by the on-board TCAS.

A “quick-look” on each day of FT4 test flights will be performed to assess the prospects of successful flight tests both during the flights and immediately post-flight. Refer to IT&E DMP-001 for a description of roles and responsibilities related data analysis pertaining to “quick-look” activities and post-flight data analysis.

6.1 Summary of Data Sources from Flight Test Aircraft

Figure 19 depicts the data collection sources for DAA Scripted encounters. For a more detailed description of the data collection source information, reference the Flight Test 4 Data Management Plan, IT&E DMP-001.

7 Appendices

Appendix A Reference Documents

Document Number	Document Title
ACAS XU FTP	ACAS Xu Flight Test Plan
DCP-O-025	NASA Armstrong Aircrew Flight Operations Manual
DO-300	RTCA MOPS for TCAS II Hybrid Surveillance
EAFBI 13-100	Edward AFB Instruction Flying and Airfield Operations
IT&E ADD-04	Architecture Description Document for FT4
IT&E DMP-001	Flight Test 4 Data Management Plan
IT&E FT4 CONOPS.r	Flight Test 4 Concept of Operations
IT&E FT4 FTRD.REQ.R1	Flight Test 4 Requirements Document
IT&E FT4 ORD-02	Flight Test 4 Operational Requirements Document
IT&E FTP-01	Flight Test 3 Flight Test Plan
NPR 7900.3	Aircraft Management Operations
R-2508	R-2508 Complex Users Handbook
Title 14 CFR Part 91	General Operating and Flight Rules

Appendix B Acronyms

ACAS	Airborne Collision Avoidance System
ACE	Active Coordination Emulation
ADRS	Aeronautical Data Link and Radar Simulator
ADS-B	Automatic Dependent Surveillance-Broadcast
AESA	Active Electronically Scanned Array
AFRC	Armstrong Flight Research Center
AFRL	Air Force Research Laboratory
AFSR	Airworthiness and Flight Safety Review
AFTC	Air Force Test Center
APL	Applied Physics Laboratory
ARC	Ames Research Center
ARTCC	Air Route Traffic Control Center
ASTERIX	**A**ll Purpose **ST**ructured **E**urocontrol Su**R**veillance **I**nformation E**X**change
ATAR	Air-To-Air-Radar
ATC	Air Traffic Control
C2	Command and Control
CA	Collision Avoidance
CAS	Collision Avoidance Systems
CAT	Collision Avoidance Threshold
CDTI	Cockpit Display Of Traffic Information
CFR	Civil Flight Regulations
COA	Certificate of Authorization
COMM	Communications
CONOPS	Concept of Operations
CoPE	Co-Project Engineers
CNPC	Control and Non-Payload Communications
CPA	Closest Point of Approach
CPDS	Conflict Prediction and Display System
CSSA	Corrective Self-Separation Alert
CV	Collision Volume
CVSRF	Crew Vehicle Simulation Research Facility
DAA	Detect and Avoid
DAIDALUS	Detect & AvoID Alerting Logic for Unmanned Systems

DATR	Dryden Aeronautical Test Range
DCP	Dryden Centerwide Procedure
DGPS	Differential Global Positioning System
DHS	Department of Homeland Security
DO	Director of Operations
DP	Descent Point
DPMf	Deputy Program Manager for
DRR	Due Regard Radar
DSRL	Distributed System Research Laboratory
EAFB	Edwards Air Force Base
EAFBI	Edwards Air Force Base Instruction
EC	Experimental Certificate
EDM	Engineering Development Module/Model
EP	Entry Point
ERAM	En Route Automation Modernization
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulations
FBO	Fixed Base Operator
FDDRL	Flight Deck Display Research Laboratory
FOM	Figure of Merit
FOV	Field of View
FP	Flight Prototype
FRR	Flight Readiness Review
FT3	Flight Test 3
FT4	Flight Test 4
FTP	Flight Test Plan
GA-ASI	General Atomics Aeronautical Systems Inc
GCS	Ground Control Station
GPS	Global Positioning System
GRC	Glenn Research Center
HSI	Human Systems Integration
HITL	Human In The Loop
HLA	High Level Architecture
HW	Honeywell
IAW	In Accordance With
IFR	Instrument Flight Rules

IP	Initial Point
IT&E	Integrated Test and Evaluation
ITAR	International Traffic In Arms Regulations
JADEM	Java Architecture for DAA Extensibility and Modeling
KGS	Knots Ground Speed
LaRC	Langley Research Center
LOS	Loss of Separation or Line of Sight
LVC	Live Virtual Constructive
MACS	Multi Aircraft Control System
MD	Mission Director
MHz	Mega Hertz
MOA	Military Operating Area
MOPS	Minimum Operational Performance Standards
MP	Maneuver Point
MRU	Military Radar Unit
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NMAC	Near Mid-Air Collisions
NMI	Nautical Mile
NOTAMS	Notice To Airmen
NPR	NASA Procedural Requirements
PE s	Project Engineers
PSSA	Preventative Self-Separation Alert
PT4	Part Task Four
QNH	Barometric Pressure Adjusted to Sea Level (at a given station)
RA	Resolution Advisory
RAIF	Research Aircraft Integration Facility
RGCS	Research Ground Control Station
RTCA	Radio Technical Commission for Aeronautics
RUMS	Remote User Monitoring System
SAA	Sense and Avoid
SAF	Stand Alone Facility
SATCOM	Satellite Communication
SC	Special Committee
SimMgr	Simulator Manager
SMO	Spectrum Management Office

SOR	Senior Operations Representative
SPORT	Space Positioning Optical Radar Tracking
SS	Self-Separation
SSCA	Self-Separation Corrective Alert
SSI	Separation Assurance/Sense and Avoid Interoperability
SSPT	Self-Separation Proximate Traffic
SSWA	Self-Separation Warning Alert
STANAG	Standardization Agreement (NATO)
STM	Surveillance Tracking Module
TBD	To Be Determined
TC	Test Conductor
TCAS	Traffic Alert and Collision Avoidance System
TCOR	Test Coordinator
TCPA	Time to Closest Point of Approach
TD	Test Director
TSPI	Time Space Position Information
TLX	Task Load Index
ToR	Terms of Reference
TRACON	Terminal Radar Approach Control Facility
TRM	Threat Resolution Module
UAS	Unmanned Aircraft Systems
VFR	Visual Flight Rules
VHF	Very High Frequency
VID	Visual Identification
VSCS	Vigilant Spirit Control Station
WAAS	Wide Area Augmentation System
WCT	Well Clear Threshold

Appendix C Definition of Terms

Blunder	A planned vertical or horizontal maneuver performed by the intruder, ownship or both aircraft that occurs at some point during the flight test encounter to intentionally stimulate conflict alerting. The blunder maneuver is a technique by which the researcher uses to obtain data required to refine algorithm parametric logic.
Intruder	Intruder aircraft (when properly equipped) provide a target solution for the self-separation algorithm under test. Both low speed, high speed, multi-ship encounters are planned using intruder aircraft. All participating intruder aircraft will be equipped with ADS-B as a minimum.
Ownship	Ownship aircraft provide the self-separation algorithm host solution for testing airborne geospatial encounters with target (intruder) aircraft. The ownship may be a UAS or UAS surrogate aircraft. Self-separation alerting solutions are presented to the ground control station pilot who determines the best course of action based on display alerting evaluation.
Mitigated	Flight test encounters that are designed for the controlling UAS pilot to either manually respond to a self-separation or resolution advisory alert or monitor the aircraft response during an automatic resolution advisory alert. Mitigated test encounters are typically planned with vertical, lateral, and timing flight safety margins designed into the flight test encounters to help minimize the potential for an inflight collision.
STANAG	In NATO a Standardization Agreement (STANAG) defines processes, procedures, terms, and conditions for common military or technical procedures or equipment between the member countries of the alliance. Each NATO state ratifies a STANAG and implements it within their own military.
Unmitigated	The term unmitigated refers to an encounter with no self-separation (i.e., mitigating) maneuver Flight test encounters that due to adequate vertical offsets do not require an associated lateral offset for flight safety. Unmitigated encounters typically are non-maneuvering.

Appendix D Flight Test 4 Intruder Summary Matrix

Stakeholder	Single Intruder Need	Multi-Ship Need	Aircraft Intruder (Single)	Aircraft Intruders (Multi)	Intruder Speeds (KGS)
GA-CPDS	Medium Speed • ADS-B/TCAS I or II	Medium Speed (Intruder 1) • ADS-B/TCAS I or II Medium Speed (Intruder 2) • Mode C or Mode S only • ADS-B only (in S/W)	Medium • NASA 865/NASA 801/N3GC	Medium (Intruder 1) • NASA 865/NASA 801/N3GC Medium (Intruder 2) • NASA 856 • NASA 865/NASA 801/N3GC	• 150, 180
GA-TCAS	Medium Speed • ADS-B (prefer Mode S)/TCAS I or II (II preferred)	Medium Speed (Intruder 1) • ADS-B/TCAS II Medium Speed (Intruder 2) • ADS-B/TCAS I	Medium • N3GC/NASA 865/NASA 801	Medium (Intruder 1) • N3GC Medium (Intruder 2) • NASA 865/NASA 801	• 130, 150, 220
GA-Radar	• Small RCS + low speed • Medium RCS • Large RCS	• Up to 4 intruders	Small • NASA 856 Mid • NASA 865 Large • NASA 801/N3GC	• N3GC • NASA 801 • NASA 865 • NASA 856	• 65, 100 • 150, 160, 180 • 250
SSI-East (DAIDALUS)	Low Speed • ADS-B (Mode C or Mode S) Medium Speed • ADS-B/TCAS II • ADS-B/TCAS I (Mode C ok) or II High Speed • ADS-B/TCAS II	Medium Speed (Intruder 1) • ADS-B/TCAS II • ADS-B/TCAS I or II Medium Speed (Intruder 2) • ADS-B/TCAS I or II	Low • NASA 856 Medium • N3GC (req. for some) • NASA 865/NASA 801/N3GC High • NASA 808	Medium (Intruder 1) • N3GC • N3GC/NASA 865/NASA 801 Medium (Intruder 2) • N3GC/NASA 865/NASA 801	• 100 • 130, 160, 180 • 400
SSI-West (JADEM)	Low Speed • Prefer Mode C, ADS-B for reference Medium Speed • ADS-B/TCAS II (recording) • ADS-B/TCAS I or II High Speed • ADS-B (Mode S or C) • ADS-B/TCAS II (Mode S or C)	Medium Speed (Intruder 1) • ADS-B/TCAS I or II • ADS-B/TCAS II (recording) Medium Speed (Intruder 2) • ADS-B/TCAS I or II • No Transponder	Low • NASA 856 Medium • N3GC (req. for some) • NASA 865/NASA 801/N3GC High • NASA 808	Medium (Intruder 1) • N3GC/NASA 865/NASA 801 • N3GC Medium (Intruder 2) • N3GC/NASA 865/NASA 801 • NASA 865/NASA 801	• 100 • 150, 180, 200, 210 • 300, 420
HON-Tracker	Medium Speed • ADS-B (prefer Mode S)/TCAS II (prefer)	• N/A	Medium • N3GC/NASA 801/NASA 865	• N/A	• 180, 200
SC-228 V&V WG	Low Speed • Mode C or None, ADS-B for reference Medium Speed • ADS-B/TCAS II (recording) • ADS-B/TCAS I or II • Mode C Only High Speed • ADS-B/TCAS II (Mode S or C)	Low Speed • Mode C or None, no ADS-B Medium Speed • ADS-B/TCAS II (recording) • ADS-B/TCAS I or II • Mode C Only	Low • NASA 856 Medium • N3GC (req. for some) • NASA 865/NASA 801/N3GC • USAF C-12 High • NASA 808	Low • NASA 856 Medium • N3GC (req. for some) • NASA 865/NASA 801/N3GC • USAF C-12	• 100 • 130, 150, 180 • 420

Appendix E VSCS/DAA MOPS Alerting Symbology

Symbol	Name	**Pilot Action**	Aural Alert Verbiage
	TCAS RA (*Cooperative Only*)	• ***Immediate action required*** • No researcher coordination required	"Climb/Descend"
	DAA Warning Alert	• ***Immediate action required*** • No researcher coordination required	"Traffic, Maneuver Now"
	Corrective DAA Alert	• On current course, ***corrective action required*** • Coordinate maneuver with researcher prior to maneuvering	"Traffic, Avoid"
	Preventive DAA Alert	• **No action required** • No coordination required	"Traffic, Monitor"
	None (Target)	• **No action required** • No coordination required	N/A

Appendix F Flight Test Objective Templates

1. JADEM
2. DAIDALUS
3. CPDS
4. Radar
5. TCAS
6. Tracker
7. SC-228

National Aeronautics and Space Administration

UAS in the NAS
FT4 Test Objectives
(SSI-ARC)

SSI-ARC FT4 Objectives

1. Validate DAA requirements in stressing cases that drive MOPS requirements, including: High-speed cooperative intruder, Low-speed non-cooperative intruder, high vertical closure rate encounter, and Mode C only intruder (i.e. without ADS-B).

2. Validate TCAS/DAA alerting and guidance interoperability concept in the presence of realistic sensor, tracking and navigational errors and in multiple-intruder encounters against both cooperative and non-cooperative intruders.

3. Validate 'Well Clear Recovery' guidance in the presence of realistic sensor, tracking and navigational errors.

4. Validate DAA alerting and guidance requirements in the presence of realistic sensor, tracking and navigational errors.

5. Collect data to support development and validation of trajectories specified in the DAA MOPS for DAA system acceptance testing.

6. Collect data to supplement simulation analyses as needed due to highly variable, preliminary or inconclusive simulation results, leveraging data from other test cases when possible (e.g., 'well clear recover' validation to supplement mini-HitL results if necessary).

Additional Info

- Objectives 5 & 6 are ‘targets of opportunity’ and will rely on data collected in the other encounters to meet the stated SSI FT4 objectives. No new FT4 requirements will be levied from these objectives, but encounters may be refined to more closely match those detailed in the SC-228 verification test trajectories where practical.
- # of Encounters:
  - Objective 1: 18
  - Objective 2: 29
  - Objective 3: 9
  - Objective 4: 16
  - Total: 72
  - Lower priority encounters: 9

FT4 TEST OBJECTIVES – SSIWest.1.a

Objective 1: Validate DAA requirements in stressing cases that drive MOPS requirements: (a) high speed intruder (mitigated, >10kft MSL)

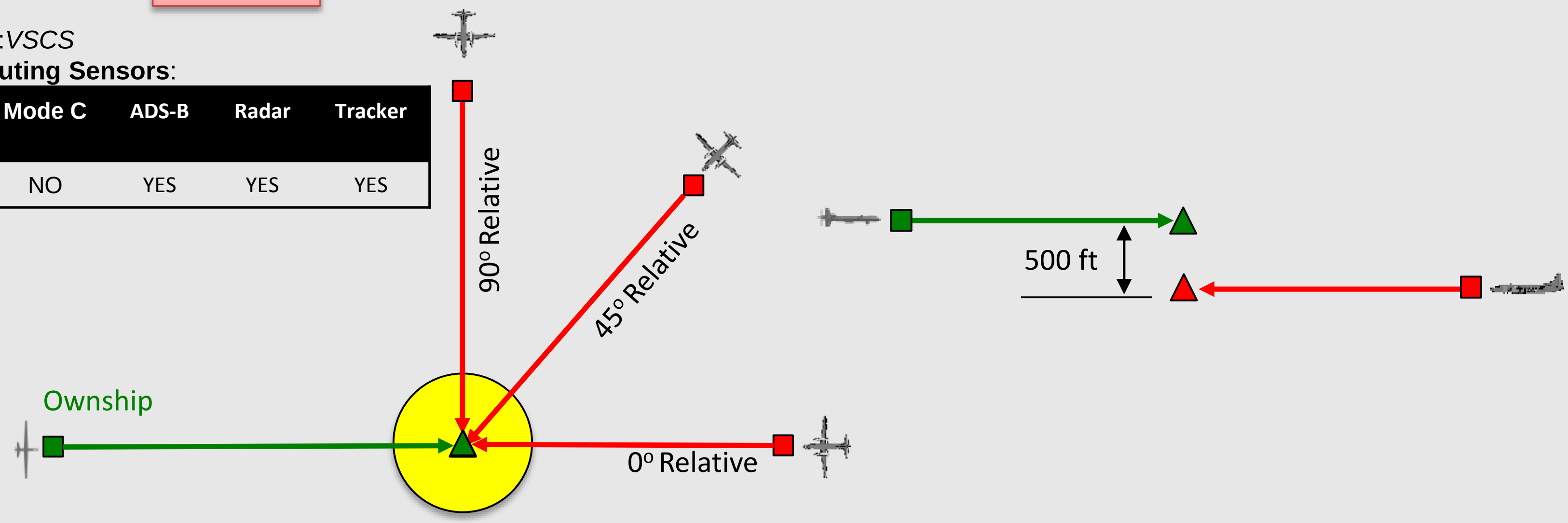
MOPS Appendix D, Section 2.3 – Aircraft Speed Limitations

Configuration

System Under Test: **Omnibands**

Display:*VSCS*
Contributing Sensors:

TCA S	Mode C	ADS-B	Radar	Tracker
YES	NO	YES	YES	YES



Lateral Offset = 0 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 500 ft

Scenario(s): #001-003

Test Objectives (TO)

1. Validate DAA alert timing allows pilot sufficient time to assess options and maneuver to remain well clear.
2. Validate DAA guidance to UAS pilot is appropriate (reasonable, timely & responsive).
3. Validate selected DAA maneuver results in remaining well clear, and removal of the alert once clear of threat.

Success Criteria (retest if criteria not met)

1. A timely (corrective initially) DAA alert is provided to the UAS pilot.
2. UAS pilot maneuvers in response to DAA alert.
3. Data collected: LVC log file, SAAProc log files, TCAS log files for ownship and intruder, SAAP file ('raw' surveillance data).

Test Method

- MANUEVER: Pilot to manually select and execute 'minimum' maneuver at edge of band (or quantized altitude level).
- Aircraft speeds (non-accelerating): Ownship 200 KTAS, Intruder >500 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nmi., no DAA alerts displayed.
- Climb/Roll/Pitch Rates: 0/0/0
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. UAS pilot receives DAA corrective alert with associated guidance
2. UAS pilot maneuvers in response to DAA alert and remains well clear of intruder.
3. DAA alert(s) and guidance are removed once ownship is clear of threat.

Additional Information

FT4 TEST OBJECTIVES – SSIWest.1.b

Objective 1: Validate DAA requirements in stressing cases that drive MOPS requirements: (b) high speed intruder (unmitigated, >10kft MSL)

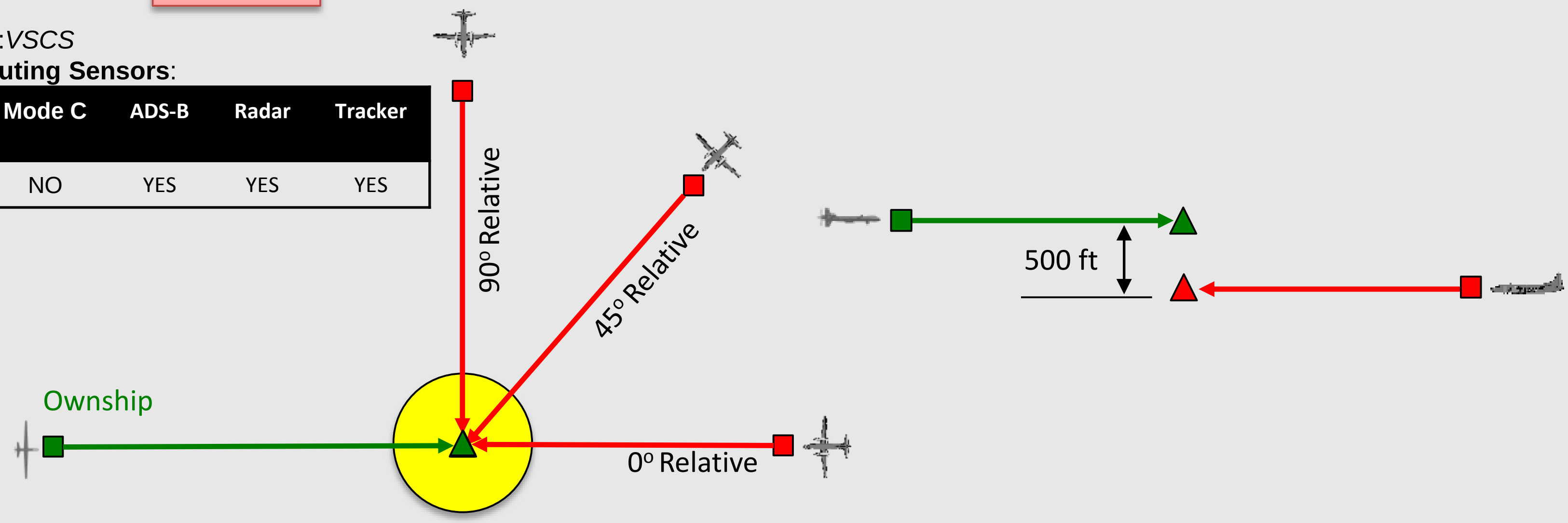
MOPS Appendix D, Section 2.3 – Aircraft Speed Limitations

Configuration

System Under Test: **Omnibands**

Display: *VSCS*
Contributing Sensors:

TCAS	Mode C	ADS-B	Radar	Tracker
YES	NO	YES	YES	YES



Lateral Offset = 0 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 500 ft

Scenario(s): #004-006

Test Objectives (TO)

1. Validate DAA alert timing allows pilot sufficient time to assess options and maneuver to remain well clear.
2. Validate DAA guidance to UAS pilot is appropriate (reasonable, timely & responsive).
3. Validate removal of DAA alert(s) once clear of threat.

Success Criteria (retest if criteria not met)

1. A timely (corrective initially) DAA alert is provided to the UAS pilot.
2. Well Clear Recovery guidance is provided to the UAS pilot prior to CPA.
3. Data collected: LVC log file, SAAProc log files, TCAS log files for ownship and intruder, SAAP file (‘raw’ surveillance data).

Test Method

- MANUEVER: none.
- Aircraft speeds (non-accelerating): Ownship 200 KTAS, Intruder >500 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nmi., no DAA alerts displayed.
- Climb/Roll/Pitch Rates: 0/0/0
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. UAS pilot receives DAA corrective alert with associated guidance
2. DAA alert(s) and guidance are removed once ownship is clear of threat.
3. CPA prediction accuracy sufficient for DAA function.

Additional Information

FT4 TEST OBJECTIVES – SSIWest.1.c

Objective 1: Validate DAA requirements in stressing cases that drive MOPS requirements: (c) high speed intruder (mitigated, <10kft MSL)

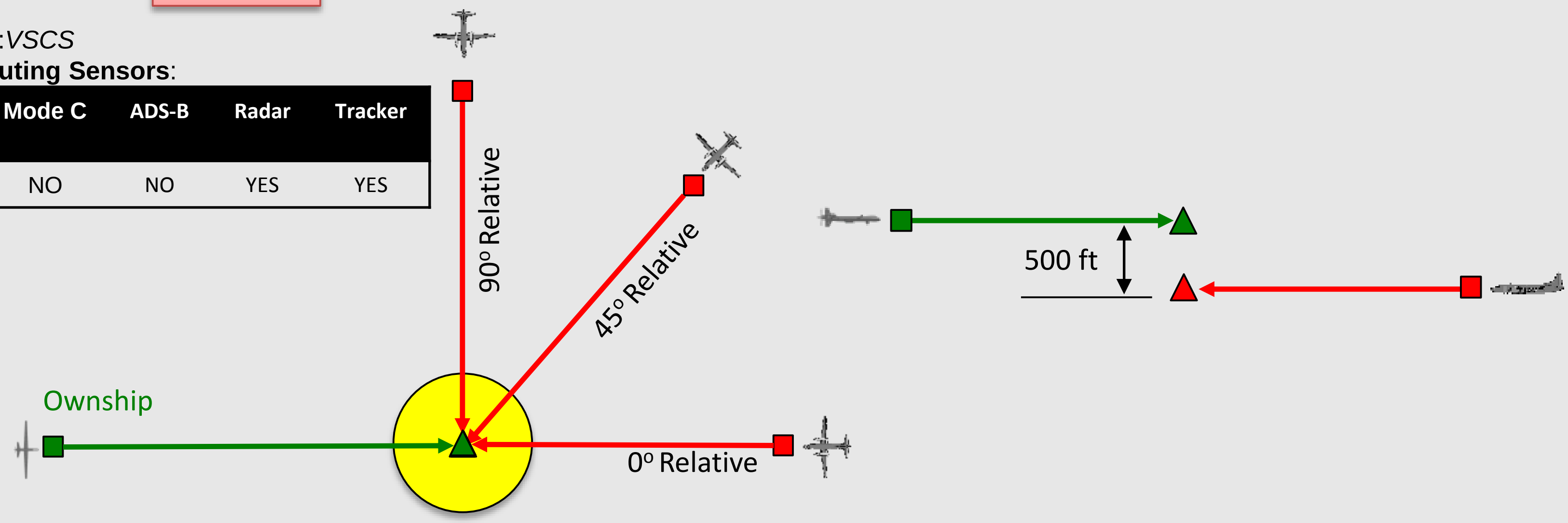
MOPS Appendix D, Section 2.3 – Aircraft Speed Limitations

Configuration

System Under Test: **Omnibands**

Display: *VSCS*
Contributing Sensors:

TCAS	Mode C	ADS-B	Radar	Tracker
NO	NO	NO	YES	YES



Lateral Offset = 0 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 500 ft

Scenario(s): #007-009

Test Objectives (TO)

1. Validate DAA alert timing allows pilot sufficient time to assess options and maneuver to remain well clear.
2. Validate DAA guidance to UAS pilot is appropriate (reasonable, timely & responsive).
3. Validate selected DAA maneuver results in remaining well clear, and removal of the alert once clear of threat.

Success Criteria (retest if criteria not met)

1. A timely (corrective initially) DAA alert is provided to the UAS pilot.
2. UAS pilot maneuvers in response to DAA alert.
3. Data collected: LVC log file, SAAProc log files, TCAS log files for ownship and intruder, SAAP file ('raw' surveillance data).

Test Method

- MANUEVER: Pilot to manually select and execute 'minimum' maneuver at edge of band (or quantized altitude level).
- Aircraft speeds (non-accelerating): Ownship 200 KTAS, Intruder 250 KIAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nmi., no DAA alerts displayed.
- Climb/Roll/Pitch Rates: 0/0/0
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. UAS pilot receives DAA corrective alert with associated guidance
2. UAS pilot maneuvers in response to DAA alert and remains well clear of intruder.
3. DAA alert(s) and guidance are removed once ownship is clear of threat.

Additional Information

FT4 TEST OBJECTIVES – SSIWest.1.d

Objective 1: Validate DAA requirements in stressing cases that drive MOPS requirements: (d) high speed intruder (unmitigated, <10kft MSL)

MOPS Appendix D, Section 2.3 – Aircraft Speed Limitations

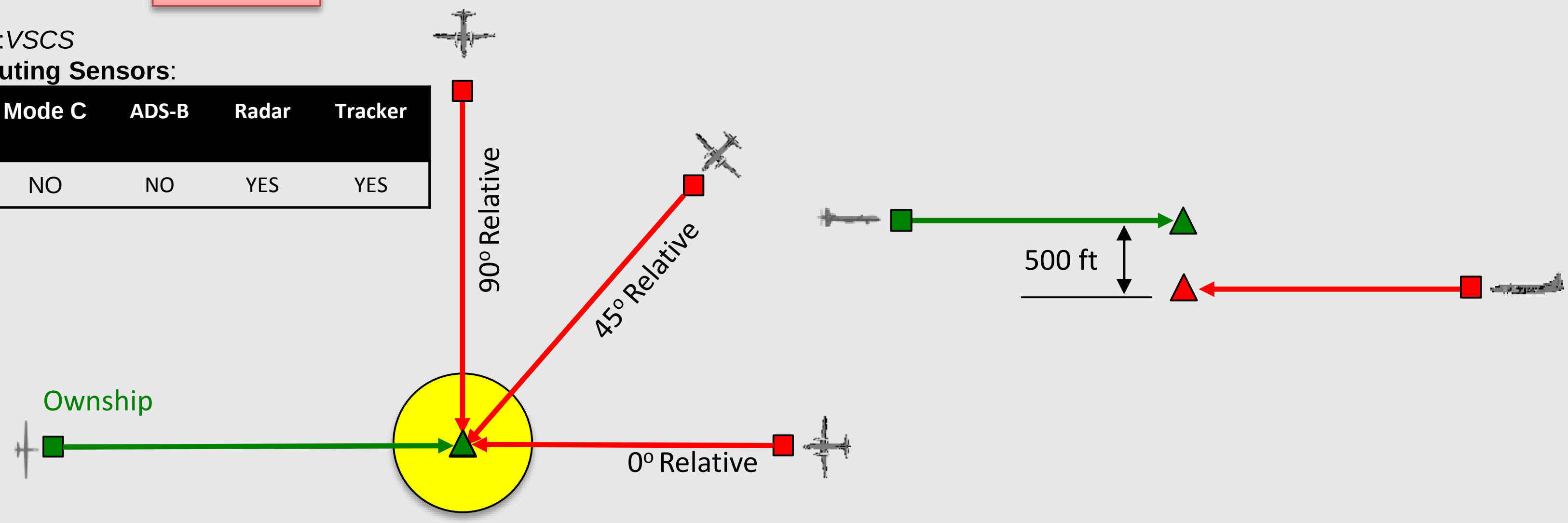
Configuration

System Under Test: **Omnibands**

Display: *VSCS*

Contributing Sensors:

TCAS	Mode C	ADS-B	Radar	Tracker
NO	NO	NO	YES	YES



Scenario(s): #010-012

Lateral Offset = 0 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 500 ft

Test Objectives (TO)

1. Validate DAA alert timing allows pilot sufficient time to assess options and maneuver to remain well clear.
2. Validate DAA guidance to UAS pilot is appropriate (reasonable, timely & responsive).
3. Validate removal of DAA alert(s) once clear of threat.

Success Criteria (retest if criteria not met)

1. A timely (corrective initially) DAA alert is provided to the UAS pilot.
2. Well Clear Recovery guidance is provided to the UAS pilot prior to CPA.
3. Data collected: LVC log file, SAAProc log files, TCAS log files for ownship and intruder, SAAP file ('raw' surveillance data).

Test Method

- MANUEVER: none.
- Aircraft speeds (non-accelerating): Ownship 200 KTAS, Intruder 250 KIAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nmi., no DAA alerts displayed.
- Climb/Roll/Pitch Rates: 0/0/0
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. UAS pilot receives DAA corrective alert with associated guidance
2. DAA alert(s) and guidance are removed once ownship is clear of threat.
3. CPA prediction accuracy sufficient for DAA function.

Additional Information

FT4 TEST OBJECTIVES – SSIWest.1.e

Objective 1: Validate DAA requirements in stressing cases that drive MOPS requirements: (e) low speed intruder (mitigated, <10kft MSL)

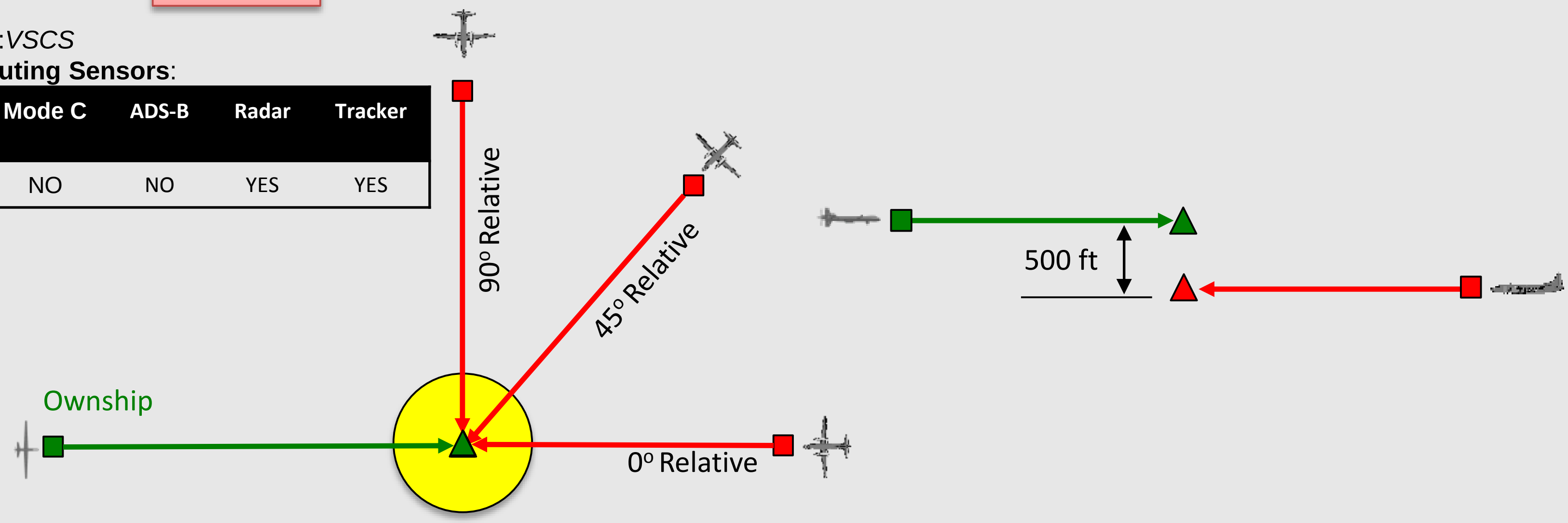
ACES Simulation Results – Common non-cooperative encounters

Configuration

System Under Test: **Omnibands**

Display: *VSCS*
Contributing Sensors:

TCAS	Mode C	ADS-B	Radar	Tracker
NO	NO	NO	YES	YES



Scenario(s): #013-015

- Lateral Offset = 0 NM
- SS Alerting Boundary = 0.75 NM
- Minimum Altitude Offset ≥ 500 ft

Test Objectives (TO)

1. Validate DAA alert timing allows pilot sufficient time to assess options and maneuver to remain well clear.
2. Validate DAA guidance to UAS pilot is appropriate (reasonable, timely & responsive).
3. Validate selected DAA maneuver results in remaining well clear, and removal of the alert once clear of threat.

Success Criteria (retest if criteria not met)

1. A timely (corrective initially) DAA alert is provided to the UAS pilot.
2. UAS pilot maneuvers in response to DAA alert.
3. Data collected: LVC log file, SAAProc log files, TCAS log files for ownship and intruder, SAAP file ('raw' surveillance data).

Test Method

- MANUEVER: Pilot to manually select and execute 'minimum' maneuver at edge of band (or quantized altitude level).
- Aircraft speeds (non-accelerating): Ownship 120 KGS, Intruder 100 KGS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nmi., no DAA alerts displayed.
- Climb/Roll/Pitch Rates: 0/0/0
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. UAS pilot receives DAA corrective alert with associated guidance
2. UAS pilot maneuvers in response to DAA alert and remains well clear of intruder.
3. DAA alert(s) and guidance are removed once ownship is clear of threat.

Additional Information

FT4 TEST OBJECTIVES – SSIWest.1.f

Objective 1: Validate DAA requirements in stressing cases that drive MOPS requirements: (f) low speed intruder (unmitigated, <10kft MSL)

ACES Simulation Results – Common non-cooperative encounters

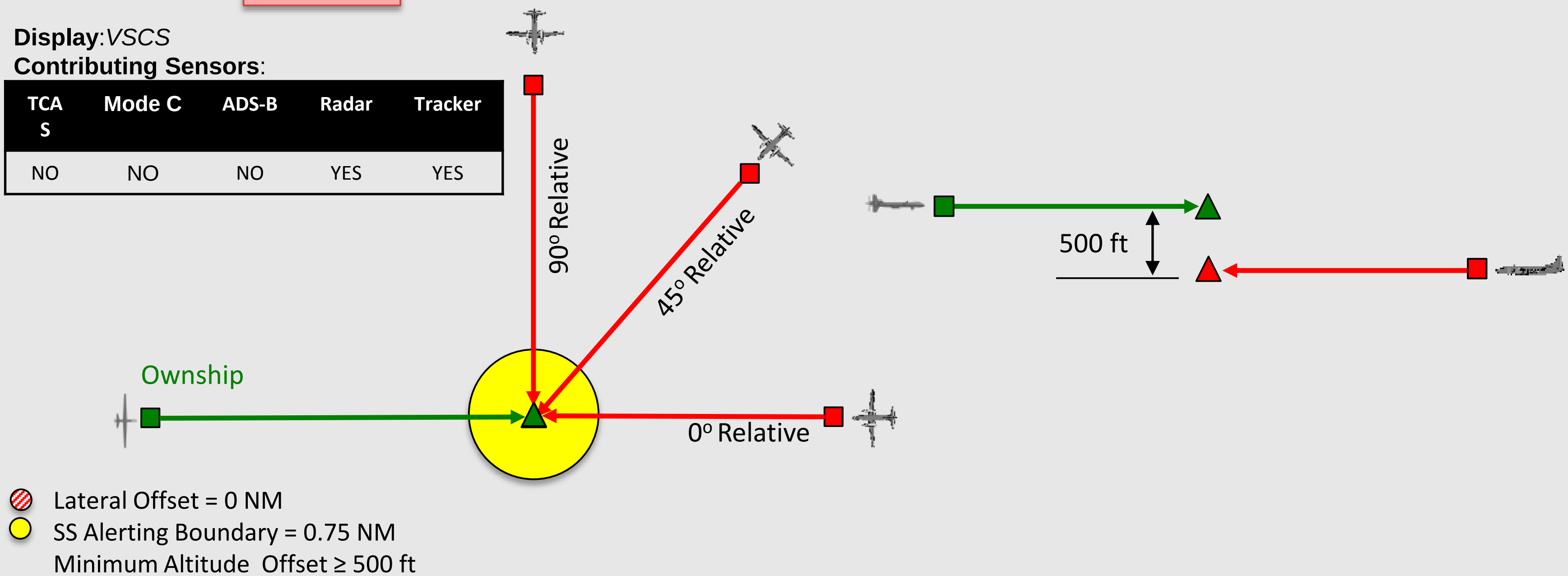
Configuration

System Under Test: Omnibands

Display: *VSCS*

Contributing Sensors:

TCAS	Mode C	ADS-B	Radar	Tracker
NO	NO	NO	YES	YES



Scenario(s): #016-018

Test Objectives (TO)

1. Validate DAA alert timing allows pilot sufficient time to assess options and maneuver to remain well clear.
2. Validate DAA guidance to UAS pilot is appropriate (reasonable, timely & responsive).
3. Validate removal of DAA alert(s) once clear of threat.

Success Criteria (retest if criteria not met)

1. A timely (corrective initially) DAA alert is provided to the UAS pilot.
2. Well Clear Recovery guidance is provided to the UAS pilot prior to CPA.
3. Data collected: LVC log file, SAAProc log files, TCAS log files for ownship and intruder, SAAP file ('raw' surveillance data).

Test Method

- MANUEVER: none.
- Aircraft speeds (non-accelerating): Ownship 120 KGS, Intruder 100 KGS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nmi., no DAA alerts displayed.
- Climb/Roll/Pitch Rates: 0/0/0
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. UAS pilot receives DAA corrective alert with associated guidance
2. DAA alert(s) and guidance are removed once ownship is clear of threat.
3. CPA prediction accuracy sufficient for DAA function.

Additional Information

FT4 TEST OBJECTIVES – SSIWest.2.a

Objective 2: Validate TCAS/DAA alerting and guidance interoperability concept in the presence of realistic sensor, tracking and navigational errors: (a) high vertical closure rate encounter (mitigated TCAS RA maneuver, >10kft).

MOPS Sections 2.2.4.2.4 Alerting 2.2.4.3 Determine Processing, 2.2.4.4 Collision Avoidance Interoperability

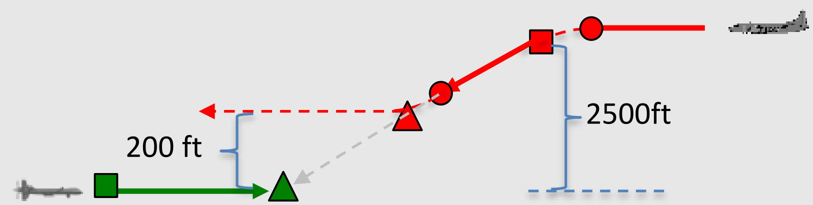
Configuration

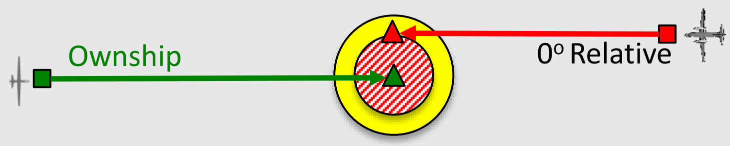
System Under Test: **Omnibands**

Display:*VSCS*

Contributing Sensors:

TCAS	Mode C	ADS-B	Radar	Tracker
YES	NO	YES	YES	YES





Scenario(s): #019

Lateral Offset = 0.5 NM
TCAS Alerting Boundary = 0.80 NM
Minimum Altitude Offset: 200 ft

Test Objectives (TO)

1. Validate DAA alert timing allows pilot sufficient time to assess options and maneuver to remain well clear.
2. Validate DAA guidance to UAS pilot is appropriate (reasonable, timely & responsive).
3. Validate DAA alerting and guidance do not interfere with UAS pilot's ability to assess and follow TCAS RA guidance.

Success Criteria (retest if criteria not met)

1. A timely (corrective initially) DAA alert is provided to the UAS pilot.
2. A corrective TCAS RA is generated for the primary intruder and the UAS pilot complies with TCAS RA guidance.
3. Data collected: LVC log file, SAAProc log files, TCAS log files for ownship and intruder, SAAP file ('raw' surveillance data).

Test Method

- MANUEVER: Pilot disregards DAA guidance and follows TCAS guidance if consistent with test constraints.
- Aircraft speeds (non-accelerating): Ownship 150 KGS, Intruder 180 KGS
- Encounter Length: 1 min (IP to CPA)
- Stable Conditions: stable at the IP (1 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nmi., no DAA alerts displayed.
- Climb/Roll/Pitch Rates: Ownship 0/0/0, Intruder -2500 FPM/0/0
- Tolerance: ± 8 sec, ± 5 kts, ± 100 fpm at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. UAS pilot receives DAA corrective alert with associated guidance.
2. Vertical DAA guidance indicates no viable vertical maneuvers in temporal proximity to TCAS RA.
3. DAA alerting and guidance for the primary intruder are removed while a TCAS RA is present for the primary intruder.
4. UAS pilot promptly evaluates (and complies with) TCAS RA guidance and avoids NMAC.
5. DAA alert(s) and guidance are removed once ownship is clear of threat.

FT4 TEST OBJECTIVES – SSIWest.2.b

Objective 2: Validate TCAS/DAA alerting and guidance interoperability concept in the presence of realistic sensor, tracking and navigational errors: (b) high vertical closure rate encounter (unmitigated TCAS RA, >10kft).	MOPS Sections 2.2.4.2.4 Alerting 2.2.4.3 Determine Processing, 2.2.4.4 Collision Avoidance Interoperability

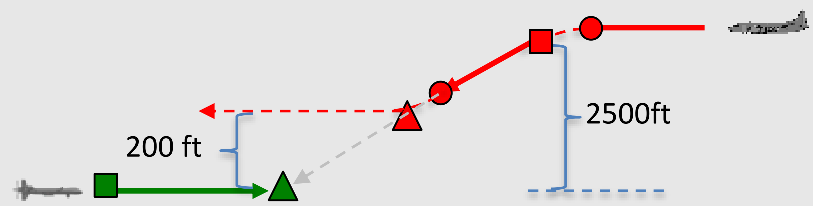
Configuration

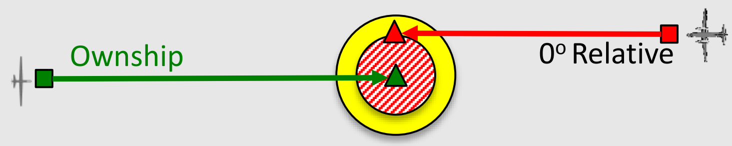
System Under Test: Omnibands

Display: *VSCS*

Contributing Sensors:

TCAS	Mode C	ADS-B	Radar	Tracker
YES	NO	YES	YES	YES





Lateral Offset = 0.5 NM

TCAS Alerting Boundary = 0.80 NM

Minimum Altitude Offset: 200 ft

Scenario(s): #020

Test Objectives (TO)

1. Validate DAA alert timing allows pilot sufficient time to assess options and maneuver to remain well clear.
2. Validate DAA guidance to UAS pilot is appropriate (reasonable, timely & responsive).
3. Validate DAA alerting and guidance do not interfere with UAS pilot's ability to assess and follow TCAS RA guidance.

Success Criteria (retest if criteria not met)

1. A timely (corrective initially) DAA alert is provided to the UAS pilot.
2. A corrective TCAS RA is generated for the primary intruder.
3. Data collected: LVC log file, SAAProc log files, TCAS log files for ownship and intruder, SAAP file ('raw' surveillance data).

Test Method

- MANUEVER: none.
- Aircraft speeds (non-accelerating): Ownship 150 KGS, Intruder 180 KGS
- Encounter Length: 1 min (IP to CPA)
- Stable Conditions: stable at the IP (1 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nmi., no DAA alerts displayed.
- Climb/Roll/Pitch Rates: Ownship 0/0/0, Intruder -2500 FPM/0/0
- Tolerance: ± 8 sec, ± 5 kts, ± 100 fpm at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. UAS pilot receives DAA corrective alert with associated guidance.
2. Vertical DAA guidance indicates no viable vertical maneuvers in temporal proximity to TCAS RA.
3. DAA alerting and guidance for the primary intruder are removed while a TCAS RA is present for the primary intruder.
4. DAA alerting and guidance is generated once RA expires (if appropriate).
5. DAA alert(s) and guidance are removed once ownship is clear of threat.

FT4 TEST OBJECTIVES – SSIWest.2.c

Objective 2: Validate TCAS/DAA alerting and guidance interoperability concept in the presence of realistic sensor, tracking and navigational errors: (c) high vertical closure rate encounter (mitigated TCAS RA maneuver, <10kft).

MOPS Sections 2.2.4.2.4 Alerting 2.2.4.3 Determine Processing, 2.2.4.4 Collision Avoidance Interoperability

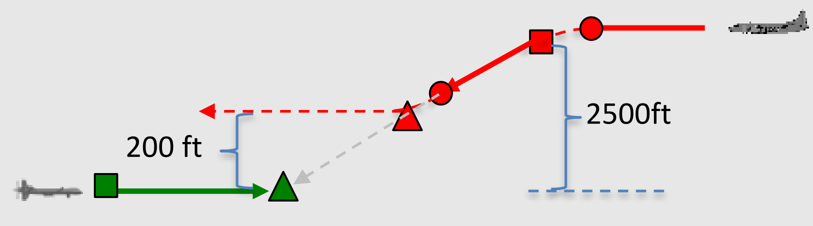
Configuration

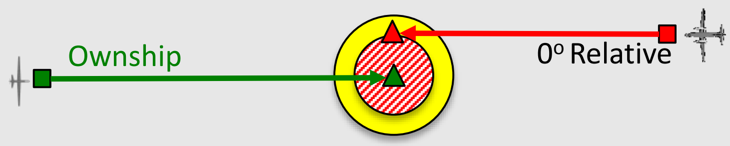
System Under Test: **Omnibands**

Display: *VSCS*

Contributing Sensors:

TCAS	Mode C	ADS-B	Radar	Tracker
YES	NO	YES	YES	YES





Lateral Offset = 0.5 NM
TCAS Alerting Boundary = 0.55 NM
Minimum Altitude Offset : 200 ft

Scenario(s): #021

Test Objectives (TO)

1. Validate DAA alert timing allows pilot sufficient time to assess options and maneuver to remain well clear.
2. Validate DAA guidance to UAS pilot is appropriate (reasonable, timely & responsive).
3. Validate DAA alerting and guidance do not interfere with UAS pilot's ability to assess and follow TCAS RA guidance.

Success Criteria (retest if criteria not met)

1. A timely (corrective initially) DAA alert is provided to the UAS pilot.
2. A corrective TCAS RA is generated for the primary intruder and the UAS pilot complies with TCAS RA guidance.
3. Data collected: LVC log file, SAAProc log files, TCAS log files for ownship and intruder, SAAP file ('raw' surveillance data).

Test Method

- MANUEVER: Pilot disregards DAA guidance and follows TCAS guidance if consistent with test constraints.
- Aircraft speeds (non-accelerating): Ownship 150 KGS, Intruder 180 KGS
- Encounter Length: 1 min (IP to CPA)
- Stable Conditions: stable at the IP (1 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nmi., no DAA alerts displayed.
- Climb/Roll/Pitch Rates: Ownship 0/0/0, Intruder -2500 FPM/0/0
- Tolerance: ± 8 sec, ± 5 kts, ± 100 fpm at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. UAS pilot receives DAA corrective alert with associated guidance.
2. Vertical DAA guidance indicates no viable vertical maneuvers in temporal proximity to TCAS RA.
3. DAA alerting and guidance for the primary intruder are removed while a TCAS RA is present for the primary intruder.
4. UAS pilot promptly evaluates (and complies with) TCAS RA guidance and avoids NMAC.
5. DAA alert(s) and guidance are removed once ownship is clear of threat.

FT4 TEST OBJECTIVES – SSIWest.2.d

Objective 2: Validate TCAS/DAA alerting and guidance interoperability concept in the presence of realistic sensor, tracking and navigational errors: (d) high vertical closure rate encounter (unmitigated TCAS RA, <10kft).

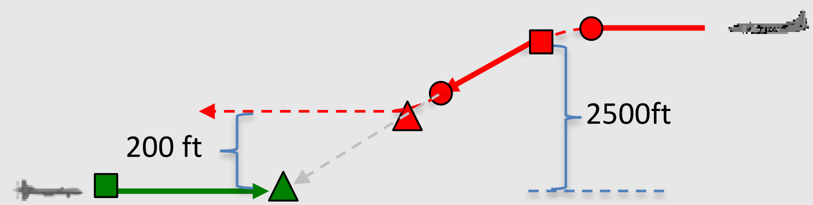
MOPS Sections 2.2.4.2.4 Alerting 2.2.4.3 Determine Processing, 2.2.4.4 Collision Avoidance Interoperability

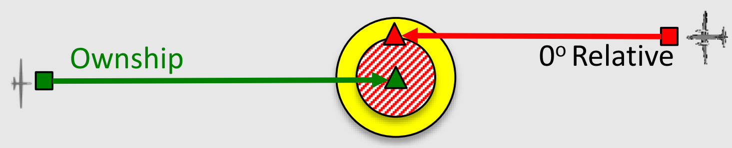
Configuration

System Under Test: **Omnibands**

Display: *VSCS*
Contributing Sensors:

TCAS	Mode C	ADS-B	Radar	Tracker
YES	NO	YES	YES	YES





Scenario(s): #022

Lateral Offset = 0.5 NM
TCAS Alerting Boundary = 0.55 NM
Minimum Altitude Offset: 200 ft

Test Objectives (TO)

1. Validate DAA alert timing allows pilot sufficient time to assess options and maneuver to remain well clear.
2. Validate DAA guidance to UAS pilot is appropriate (reasonable, timely & responsive).
3. Validate DAA alerting and guidance do not interfere with UAS pilot's ability to assess and follow TCAS RA guidance.

Success Criteria (retest if criteria not met)

1. A timely (corrective initially) DAA alert is provided to the UAS pilot.
2. A corrective TCAS RA is generated for the primary intruder.
3. Data collected: LVC log file, SAAProc log files, TCAS log files for ownship and intruder, SAAP file ('raw' surveillance data).

Test Method

- MANUEVER: none.
- Aircraft speeds (non-accelerating): Ownship 150 KGS, Intruder 180 KGS
- Encounter Length: 1 min (IP to CPA)
- Stable Conditions: stable at the IP (1 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nmi., no DAA alerts displayed.
- Climb/Roll/Pitch Rates: Ownship 0/0/0, Intruder -2500 FPM/0/0
- Tolerance: ± 8 sec, ± 5 kts, ± 100 fpm at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. UAS pilot receives DAA corrective alert with associated guidance.
2. Vertical DAA guidance indicates no viable vertical maneuvers in temporal proximity to TCAS RA.
3. DAA alerting and guidance for the primary intruder are removed while a TCAS RA is present for the primary intruder.
4. DAA alerting and guidance is generated once RA expires (if appropriate).
5. DAA alert(s) and guidance are removed once ownship is clear of threat.

FT4 TEST OBJECTIVES – SSIWest.2.e

Objective 2: Validate TCAS/DAA alerting and guidance interoperability concept in the presence of realistic sensor, tracking and navigational errors: (e) level-level TCAS RA encounters (mitigated, >10kft).	MOPS Sections 2.2.4.2.4 Alerting 2.2.4.3 Determine Processing, 2.2.4.4 Collision Avoidance Interoperability

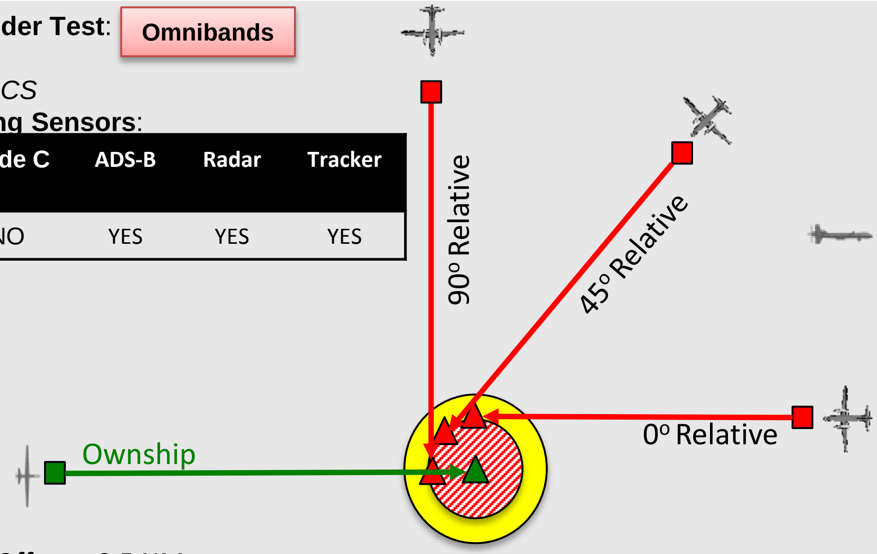
Configuration

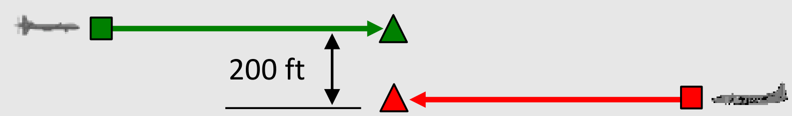
System Under Test: Omnibands

Display: *VSCS*

Contributing Sensors:

TCAS	Mode C	ADS-B	Radar	Tracker
YES	NO	YES	YES	YES





Lateral Offset = 0.5 NM

TCAS Alerting Boundary = 0.80 NM

Minimum Altitude Offset: 200 ft

Scenario(s): #023-031

Test Objectives (TO)	1. Validate DAA alert timing allows pilot sufficient time to assess options and maneuver to remain well clear. 2. Validate DAA guidance to UAS pilot is appropriate (reasonable, timely & responsive). 3. Validate DAA alerting and guidance do not interfere with UAS pilot's ability to assess and follow TCAS RA guidance.
Success Criteria (retest if criteria not met)	1. A timely (corrective initially) DAA alert is provided to the UAS pilot. 2. A corrective TCAS RA is generated for the primary intruder and the UAS pilot complies with TCAS RA guidance. 3. Data collected: LVC log file, SAAProc log files, TCAS log files for ownship and intruder, SAAP file ('raw' surveillance data).
Test Method	• MANUEVER: Pilot disregards DAA guidance and follows TCAS guidance if consistent with test constraints. • Aircraft speeds (non-accelerating): Ownship 150 KGS, Intruder 150/180/210 KGS • Encounter Length: 1 min (IP to CPA) • Stable Conditions: stable at the IP (1 minutes prior to CPA) • Test Termination Criteria: targets diverging, range > 0.75 nmi., no DAA alerts displayed. • Climb/Roll/Pitch Rates: Ownship 0/0/0, Intruder -2500 FPM/0/0 • Tolerance: ± 8 sec, ± 5 kts at IP crossing.
Evaluation Criteria (Post-test analysis to determine if test objectives are met)	1. UAS pilot receives DAA corrective alert with associated guidance. 2. Vertical DAA guidance indicates no viable vertical maneuvers in temporal proximity to TCAS RA. 3. DAA alerting and guidance for the primary intruder are removed while a TCAS RA is present for the primary intruder. 4. DAA alerting and guidance is generated once RA expires (if appropriate). 5. DAA alert(s) and guidance are removed once ownship is clear of threat.

FT4 TEST OBJECTIVES – SSIWest.2.f

Objective 2: Validate TCAS/DAA alerting and guidance interoperability concept in the presence of realistic sensor, tracking and navigational errors: (f) level-level TCAS RA encounters (unmitigated, >10kft).

MOPS Sections 2.2.4.2.4 Alerting 2.2.4.3 Determine Processing, 2.2.4.4 Collision Avoidance Interoperability

Configuration

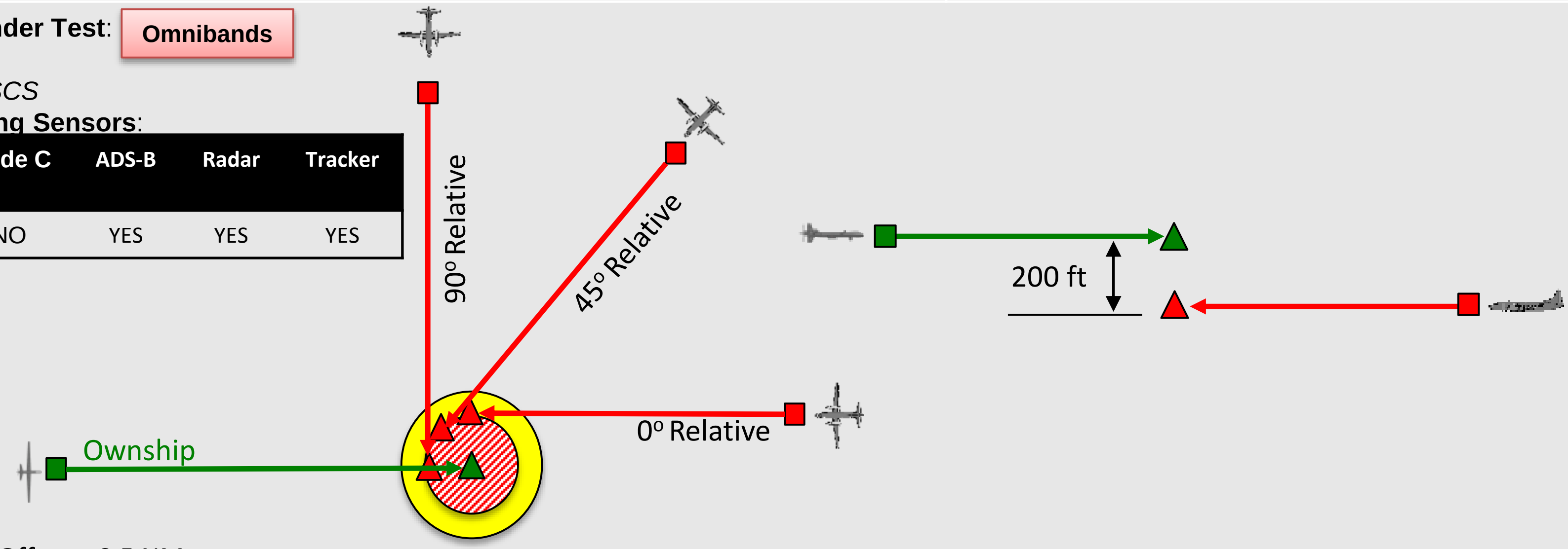
Scenario(s): #032-040

System Under Test: Omnibands

Display: *VSCS*

Contributing Sensors:

TCAS	Mode C	ADS-B	Radar	Tracker
YES	NO	YES	YES	YES



Lateral Offset = 0.5 NM

TCAS Alerting Boundary = 0.80 NM

Minimum Altitude Offset: 200 ft

Test Objectives (TO)

1. Validate DAA alert timing allows pilot sufficient time to assess options and maneuver to remain well clear.
2. Validate DAA guidance to UAS pilot is appropriate (reasonable, timely & responsive).
3. Validate DAA alerting and guidance do not interfere with UAS pilot's ability to assess and follow TCAS RA guidance.

Success Criteria (retest if criteria not met)

1. A timely (corrective initially) DAA alert is provided to the UAS pilot.
2. A corrective TCAS RA is generated for the primary intruder.
3. Data collected: LVC log file, SAAProc log files, TCAS log files for ownship and intruder, SAAP file ('raw' surveillance data).

Test Method

- MANUEVER: none.
- Aircraft speeds (non-accelerating): Ownship 150 KGS, Intruder 150/180/210 KGS
- Encounter Length: 1 min (IP to CPA)
- Stable Conditions: stable at the IP (1 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nmi., no DAA alerts displayed.
- Climb/Roll/Pitch Rates: Ownship 0/0/0, Intruder -2500 FPM/0/0
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. UAS pilot receives DAA corrective alert with associated guidance.
2. Vertical DAA guidance indicates no viable vertical maneuvers in temporal proximity to TCAS RA.
3. DAA alerting and guidance for the primary intruder are removed while a TCAS RA is present for the primary intruder.
4. DAA alerting and guidance is generated once RA expires (if appropriate).
5. DAA alert(s) and guidance are removed once ownship is clear of threat.

FT4 TEST OBJECTIVES – SSIWest.2.g

Objective 2: Validate TCAS/DAA alerting and guidance interoperability concept in the presence of realistic sensor, tracking and navigational errors: (g) level-level TCAS RA encounters (mitigated, <10kft).	MOPS Sections 2.2.4.2.4 Alerting 2.2.4.3 Determine Processing, 2.2.4.4 Collision Avoidance Interoperability

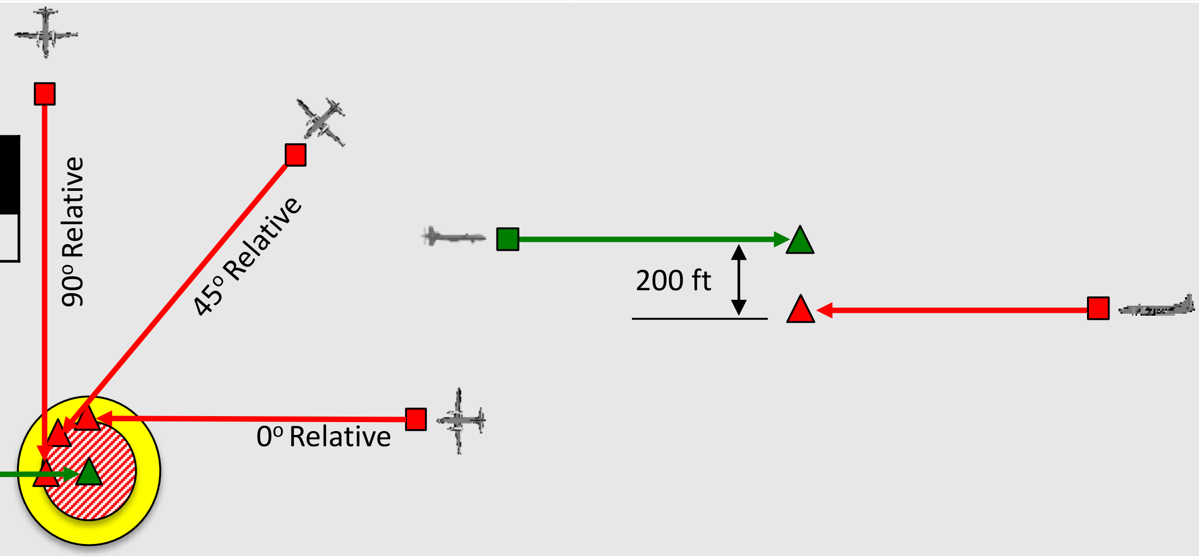
Configuration

System Under Test: Omnibands

Display:*VSCS*

Contributing Sensors:

TCAS	Mode C	ADS-B	Radar	Tracker
YES	NO	YES	YES	YES



Lateral Offset = 0.5 NM
TCAS Alerting Boundary = 0.55 NM
Minimum Altitude Offset: 200 ft

Scenario(s): #041-043

Test Objectives (TO)

1. Validate DAA alert timing allows pilot sufficient time to assess options and maneuver to remain well clear.
2. Validate DAA guidance to UAS pilot is appropriate (reasonable, timely & responsive).
3. Validate DAA alerting and guidance do not interfere with UAS pilot's ability to assess and follow TCAS RA guidance.

Success Criteria (retest if criteria not met)

1. A timely (corrective initially) DAA alert is provided to the UAS pilot.
2. A corrective TCAS RA is generated for the primary intruder and the UAS pilot complies with TCAS RA guidance.
3. Data collected: LVC log file, SAAProc log files, TCAS log files for ownship and intruder, SAAP file ('raw' surveillance data).

Test Method

- MANUEVER: Pilot disregards DAA guidance and follows TCAS guidance if consistent with test constraints.
- Aircraft speeds (non-accelerating): Ownship 150 KGS, Intruder 180 KGS
- Encounter Length: 1 min (IP to CPA)
- Stable Conditions: stable at the IP (1 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nmi., no DAA alerts displayed.
- Climb/Roll/Pitch Rates: Ownship 0/0/0, Intruder -2500 FPM/0/0
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. UAS pilot receives DAA corrective alert with associated guidance.
2. Vertical DAA guidance indicates no viable vertical maneuvers in temporal proximity to TCAS RA.
3. DAA alerting and guidance for the primary intruder are removed while a TCAS RA is present for the primary intruder.
4. DAA alerting and guidance is generated once RA expires (if appropriate).
5. DAA alert(s) and guidance are removed once ownship is clear of threat.

FT4 TEST OBJECTIVES – SSIWest.2.h

Objective 2: Validate TCAS/DAA alerting and guidance interoperability concept in the presence of realistic sensor, tracking and navigational errors: (h) level-level TCAS RA encounters (unmitigated, <10kft).	MOPS Sections 2.2.4.2.4 Alerting 2.2.4.3 Determine Processing, 2.2.4.4 Collision Avoidance Interoperability

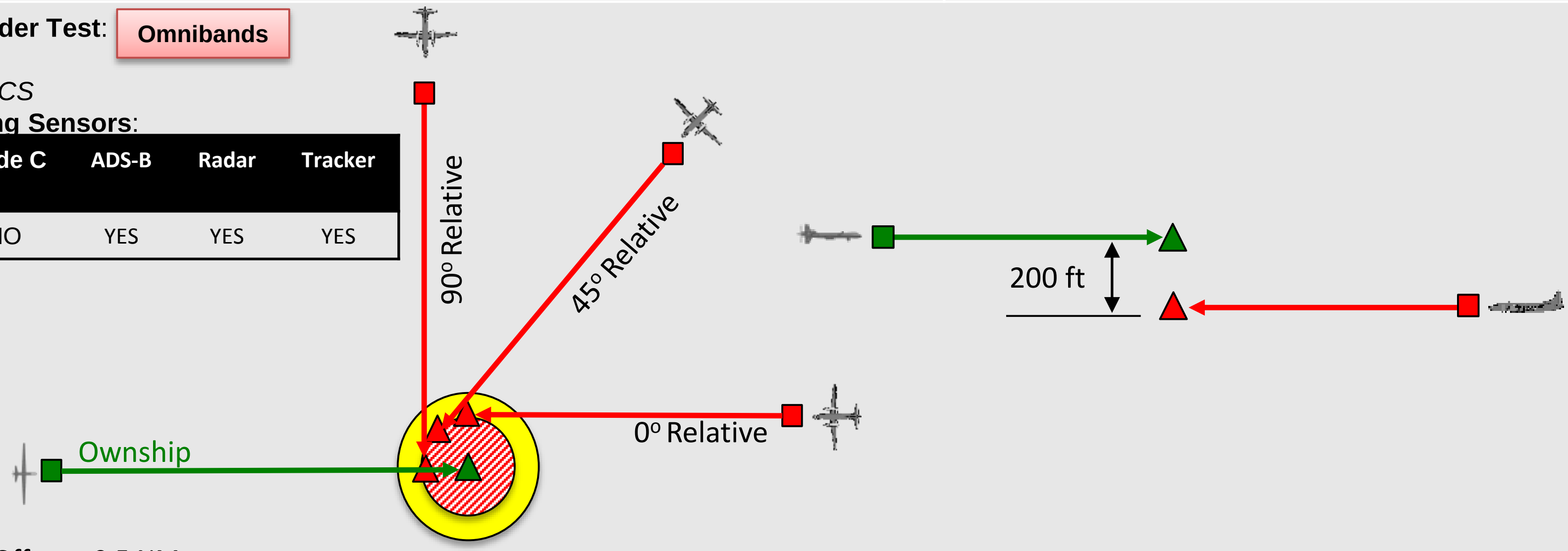
Configuration

System Under Test: Omnibands

Display: *VSCS*

Contributing Sensors:

TCAS	Mode C	ADS-B	Radar	Tracker
YES	NO	YES	YES	YES



Lateral Offset = 0.5 NM
TCAS Alerting Boundary = 0.55 NM
Minimum Altitude Offset: 200 ft

Scenario(s): #044-046

Test Objectives (TO)

1. Validate DAA alert timing allows pilot sufficient time to assess options and maneuver to remain well clear.
2. Validate DAA guidance to UAS pilot is appropriate (reasonable, timely & responsive).
3. Validate DAA alerting and guidance do not interfere with UAS pilot's ability to assess and follow TCAS RA guidance.

Success Criteria (retest if criteria not met)

1. A timely (corrective initially) DAA alert is provided to the UAS pilot.
2. A corrective TCAS RA is generated for the primary intruder.
3. Data collected: LVC log file, SAAProc log files, TCAS log files for ownship and intruder, SAAP file ('raw' surveillance data).

Test Method

- MANUEVER: none.
- Aircraft speeds (non-accelerating): Ownship 150 KGS, Intruder 180 KGS
- Encounter Length: 1 min (IP to CPA)
- Stable Conditions: stable at the IP (1 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nmi., no DAA alerts displayed.
- Climb/Roll/Pitch Rates: Ownship 0/0/0, Intruder -2500 FPM/0/0
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. UAS pilot receives DAA corrective alert with associated guidance.
2. Vertical DAA guidance indicates no viable vertical maneuvers in temporal proximity to TCAS RA.
3. DAA alerting and guidance for the primary intruder are removed while a TCAS RA is present for the primary intruder.
4. DAA alerting and guidance is generated once RA expires (if appropriate).
5. DAA alert(s) and guidance are removed once ownship is clear of threat.

FT4 TEST OBJECTIVES – SSIWest.2.i

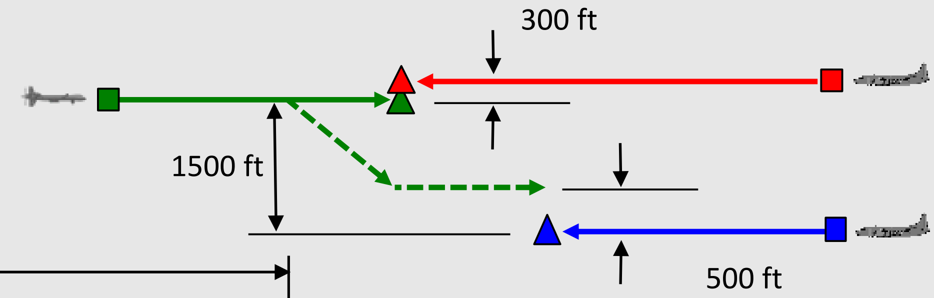
Objective 2: Validate TCAS/DAA alerting and guidance interoperability concept in the presence of realistic sensor, tracking and navigational errors: (i) multi-intruder encounter (mitigated TCAS RA maneuver, >10kft).

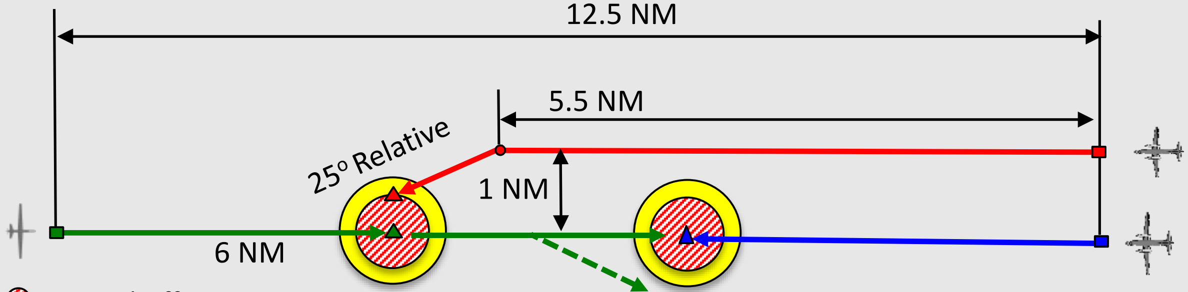
MOPS Sections 2.2.4.2.4 Alerting 2.2.4.3 Determine Processing, 2.2.4.4 Collision Avoidance Interoperability

Configuration

System Under Test: Omnibands
Display:*VSCS*
Contributing Sensors

TCAS	Mode C	ADS-B	Radar	Tracker
YES	NO	YES	YES	YES





Lateral Offset = 0.5 NM
TCAS Alerting Boundary = 0.8 NM
Minimum Altitude Offset: ≥ 300 ft (primary), 500 ft (secondary)
Initial Intruder Course Lateral Offset: 1nmi (primary), 0 nmi (secondary)

Scenario(s): #047

Test Objectives (TO)

1. Validate DAA alert timing allows pilot sufficient time to assess options and maneuver to remain well clear.
2. Validate DAA guidance to UAS pilot is appropriate (reasonable, timely & responsive).
3. Validate DAA alerting and guidance do not interfere with UAS pilot's ability to assess and follow TCAS RA guidance.

Success Criteria (retest if criteria not met)

1. A corrective TCAS RA is generated for the primary intruder and the UAS pilot complies with TCAS RA guidance.
2. A timely DAA alert for secondary intruder is provided to the UAS pilot (timely relative to TCAS maneuver initiation).
3. Data collected: LVC log file, SAAProc log files, TCAS log files for ownship and intruder, SAAP file ('raw' surveillance data).

Test Method

- MANUEVER: Pilot complies with TCAS RA for primary intruder and follows DAA guidance for secondary intruder (after RA initiation).
- Aircraft speeds (non-accelerating): Ownship 180 KGS, Primary Intruder 200 KGS, Secondary Intruder (NO ADS-B) 150 KGS.
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nmi., no DAA alerts displayed.
- Climb/Roll/Pitch Rates: Ownship & Secondary 0/0/0, Primary Intruder: TBD climb/descent to generate RA.
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. UAS pilot receives and complies with TCAS corrective RA for primary intruder.
2. Vertical DAA guidance indicates no viable vertical maneuvers in temporal proximity to TCAS RA and while RA persists.
3. DAA alerting and guidance for the primary intruder are removed while a TCAS RA is present for the primary intruder.
4. UAS pilot receives DAA Warning Alert for secondary intruder with associated guidance.
5. UAS pilot maneuvers according to DAA guidance and remains well clear of secondary intruder.

FT4 TEST OBJECTIVES – SSIWest.3.a

Objective 3: Validate Well Clear Recovery (WCR) guidance in the presence of realistic sensor, tracking and navigation errors: (a) high speed intruder (mitigated, >10kft MSL)

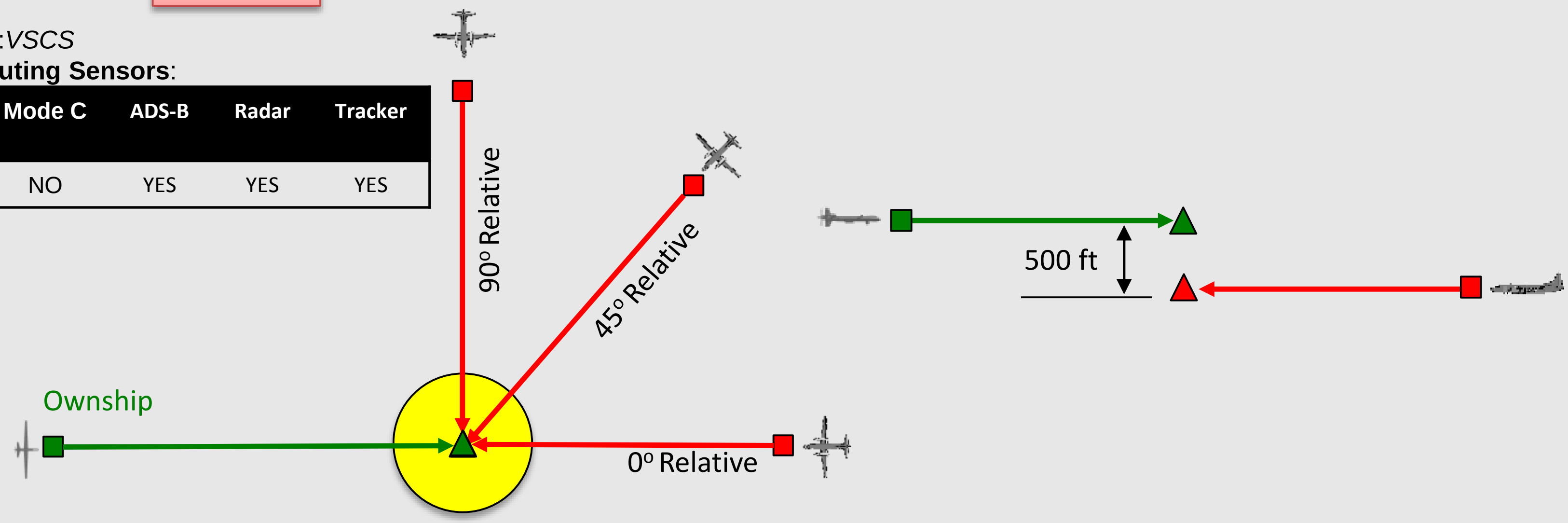
MOPS Section 2.2.4.3.2 DAA Guidance to Regain Well Clear

Configuration

System Under Test: Omnibands

Display: *VSCS*
Contributing Sensors:

TCAS	Mode C	ADS-B	Radar	Tracker
NO	NO	YES	YES	YES



Lateral Offset = 0 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 500 ft

Scenario(s): #048-050

Test Objectives (TO)

1. Validate DAA Well Clear Recovery guidance to UAS pilot is appropriate (reasonable, timely & responsive).
2. Validate WCR guidance results in pilot maneuvering to avoid collision and regain Well Clear.

Success Criteria (retest if criteria not met)

1. DAA Well Clear Recovery guidance is provided to the UAS pilot.
2. UAS pilot maneuvers in response to Well Clear Recovery guidance.
3. Data collected: LVC log file, SAAProc log files, TCAS log files for ownship and intruder, SAAP file (‘raw’ surveillance data).

Test Method

- MANUEVER: UAS pilot to ignore corrective and warning DAA alerts and respond promptly to DAA WCR guidance.
- Ignore TCAS RA guidance
- Aircraft speeds (non-accelerating): Ownship 200 KTAS, Intruder >500 KTAS
- Encounter Length: 1 min (IP to CPA)
- Stable Conditions: stable at the IP (1 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nmi., no DAA alerts displayed.
- Climb/Roll/Pitch Rates: 0/0/0
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. UAS pilot receives DAA Well Clear Recovery guidance
2. UAS pilot maneuvers in response to DAA Well Clear Recovery guidance and regains well clear of intruder.
3. DAA alert(s) and guidance are removed once ownship is clear of threat.

Additional Information

FT4 TEST OBJECTIVES – SSIWest.3.b

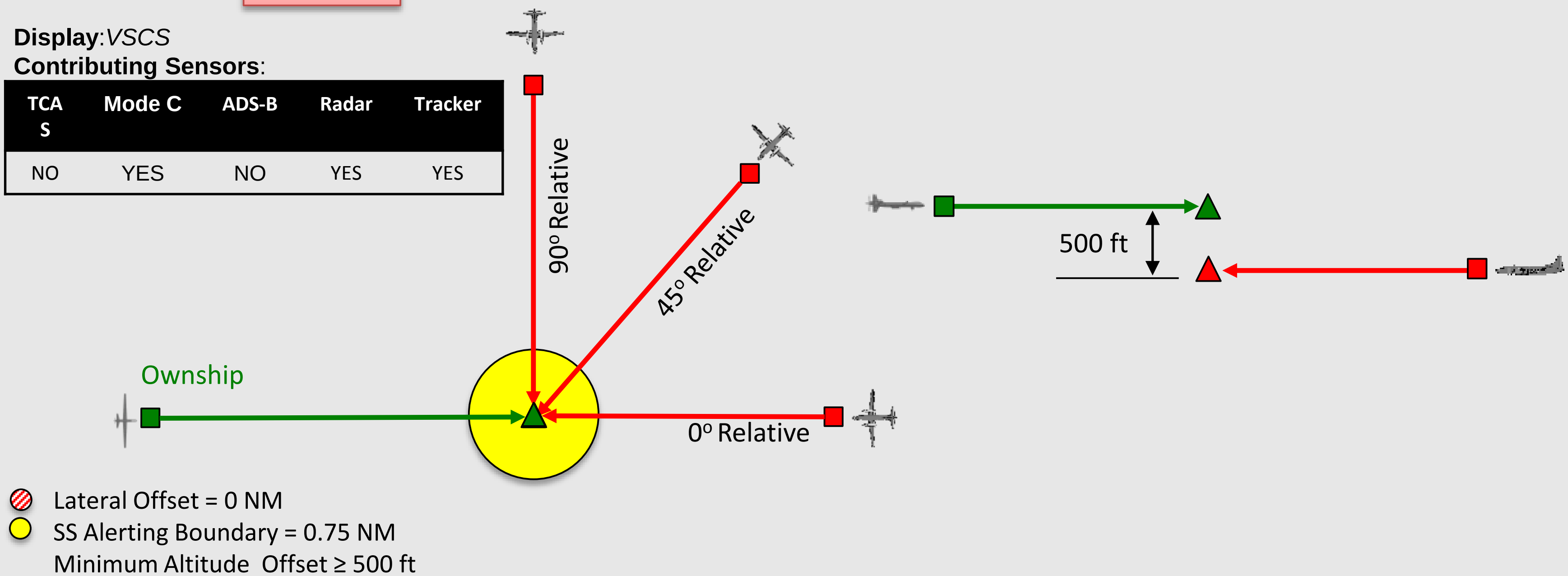
Objective 3: Validate Well Clear Recovery (WCR) guidance in the presence of realistic sensor, tracking and navigation errors: (b) high speed intruder (mitigated, <10kft MSL)	**MOPS Section 2.2.4.3.2 DAA Guidance to Regain Well Clear**

Configuration

System Under Test: Omnibands

Display: *VSCS*
Contributing Sensors:

TCAS	Mode C	ADS-B	Radar	Tracker
NO	YES	NO	YES	YES



Scenario(s): #051-053

Test Objectives (TO)	1. Validate DAA Well Clear Recovery guidance to UAS pilot is appropriate (reasonable, timely & responsive). 2. Validate WCR guidance results in pilot maneuvering to avoid collision and regain Well Clear.
Success Criteria (retest if criteria not met)	1. DAA Well Clear Recovery guidance is provided to the UAS pilot. 2. UAS pilot maneuvers in response to Well Clear Recovery guidance. 3. Data collected: LVC log file, SAAProc log files, TCAS log files for ownship and intruder, SAAP file (‘raw’ surveillance data).
Test Method	• MANUEVER: UAS pilot to ignore corrective and warning DAA alerts and respond promptly to DAA WCR guidance. • Ignore TCAS RA guidance • Aircraft speeds (non-accelerating): Ownship 200 KTAS, Intruder 250 KIAS • Encounter Length: 1 min (IP to CPA) • Stable Conditions: stable at the IP (1 minutes prior to CPA) • Test Termination Criteria: targets diverging, range > 0.75 nmi., no DAA alerts displayed. • Climb/Roll/Pitch Rates: 0/0/0 • Tolerance: ± 8 sec, ± 5 kts at IP crossing.
Evaluation Criteria (Post-test analysis to determine if test objectives are met)	1. UAS pilot receives DAA Well Clear Recovery guidance 2. UAS pilot maneuvers in response to DAA Well Clear Recovery guidance and regains well clear of intruder. 3. DAA alert(s) and guidance are removed once ownship is clear of threat.
Additional Information	

FT4 TEST OBJECTIVES – SSIWest.3.c

Objective 3: Validate Well Clear Recovery (WCR) guidance in the presence of realistic sensor, tracking and navigation errors: (c) low speed intruder (mitigated, <10kft MSL)

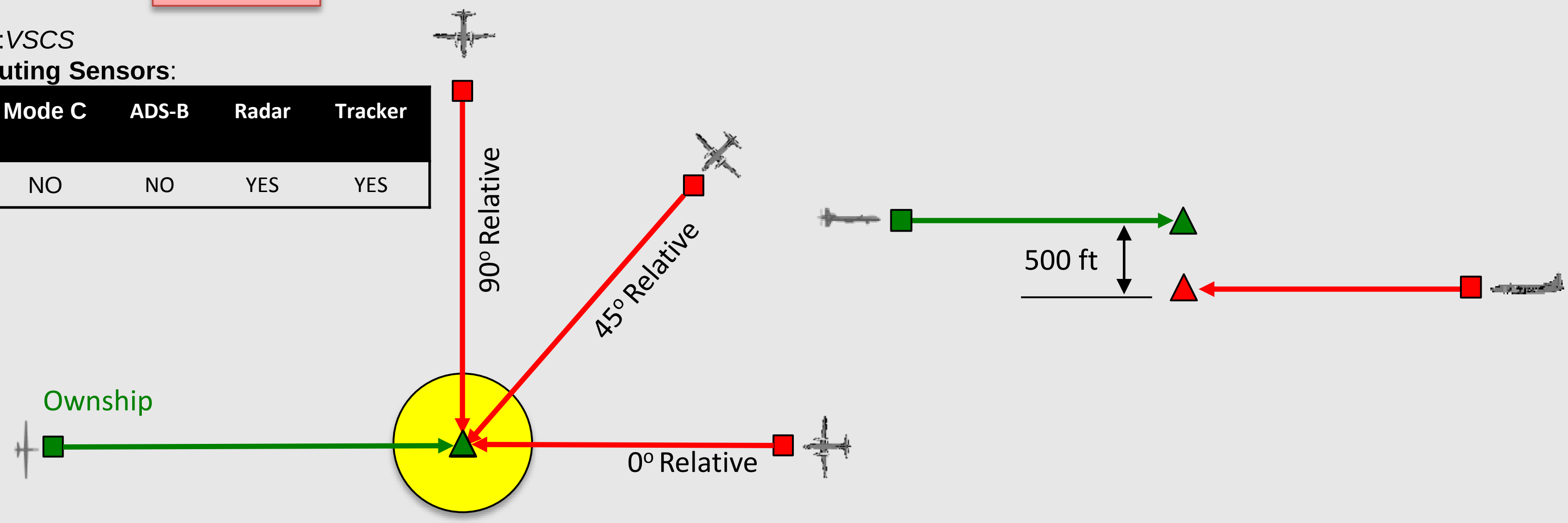
MOPS Section 2.2.4.3.2 DAA Guidance to Regain Well Clear

Configuration

System Under Test: Omnibands

Display: *VSCS*
Contributing Sensors:

TCAS	Mode C	ADS-B	Radar	Tracker
NO	NO	NO	YES	YES



Lateral Offset = 0 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 500 ft

Scenario(s): #054-056

Test Objectives (TO)

1. Validate DAA Well Clear Recovery guidance to UAS pilot is appropriate (reasonable, timely & responsive).
2. Validate WCR guidance results in pilot maneuvering to avoid collision and regain Well Clear.

Success Criteria (retest if criteria not met)

1. DAA Well Clear Recovery guidance is provided to the UAS pilot.
2. UAS pilot maneuvers in response to Well Clear Recovery guidance.
3. Data collected: LVC log file, SAAProc log files, TCAS log files for ownship and intruder, SAAP file (‘raw’ surveillance data).

Test Method

- MANUEVER: UAS pilot to ignore corrective and warning DAA alerts and respond promptly to DAA WCR guidance.
- Ignore TCAS RA guidance
- Aircraft speeds (non-accelerating): Ownship 120 KGS, Intruder 100 KGS
- Encounter Length: 1 min (IP to CPA)
- Stable Conditions: stable at the IP (1 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nmi., no DAA alerts displayed.
- Climb/Roll/Pitch Rates: 0/0/0
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. UAS pilot receives DAA Well Clear Recovery guidance
2. UAS pilot maneuvers in response to DAA Well Clear Recovery guidance and regains well clear of intruder.
3. DAA alert(s) and guidance are removed once ownship is clear of threat.

Additional Information

FT4 TEST OBJECTIVES – SSIWest.4.a

Objective 4: Validate DAA alerting and guidance requirements in the presence of realistic sensor, tracking and navigational errors: a) nominal speed encounter (mitigated, >10kft)

MOPS Sections 2.2.4.2.4 Alerting 2.2.4.3 Determine Processing

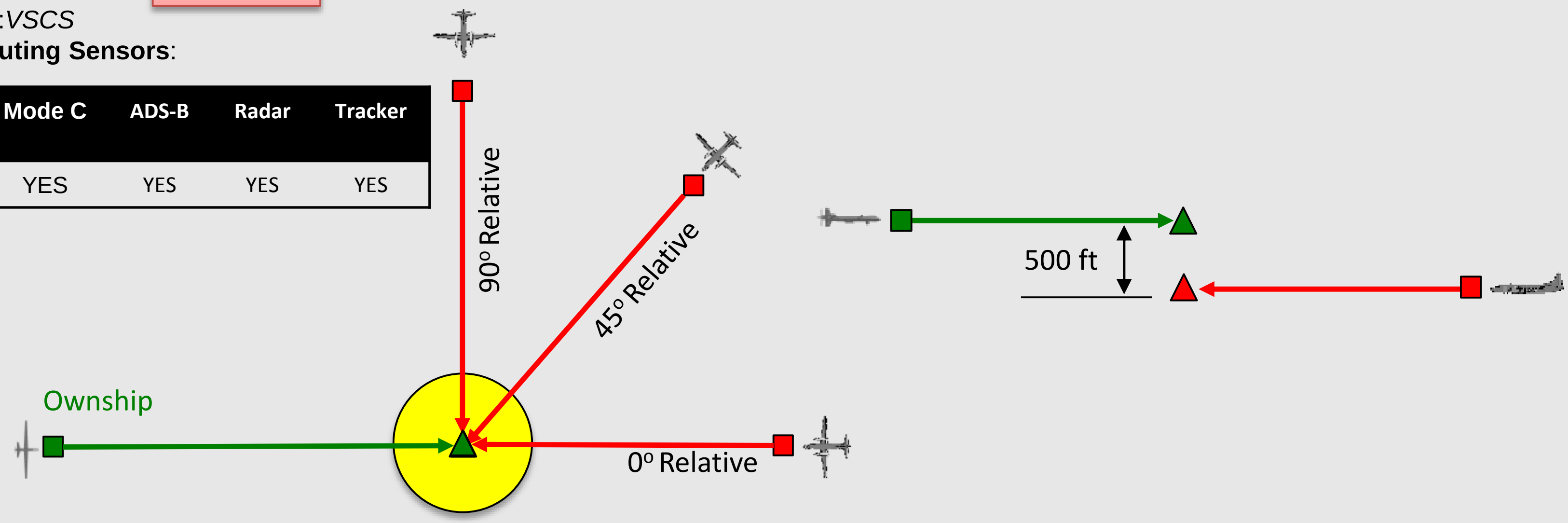
Configuration

System Under Test: Omnibands

Display: *VSCS*

Contributing Sensors:

TCAS	Mode C	ADS-B	Radar	Tracker
YES	YES	YES	YES	YES



Lateral Offset = 0 NM

SS Alerting Boundary = 0.75 NM

Minimum Altitude Offset ≥ 500 ft

Scenario(s): #057-059

Test Objectives (TO)

1. Validate DAA alert timing allows pilot sufficient time to assess options and maneuver to remain well clear.
2. Validate DAA guidance to UAS pilot is appropriate (reasonable, timely & responsive).
3. Validate selected DAA maneuver results in remaining well clear, and removal of the alert once clear of threat.

Success Criteria (retest if criteria not met)

1. A timely (corrective initially) DAA alert is provided to the UAS pilot.
2. UAS pilot maneuvers in response to DAA alert.
3. Data collected: LVC log file, SAAProc log files, TCAS log files for ownship and intruder, SAAP file ('raw' surveillance data).

Test Method

- MANUEVER: Pilot to manually select and execute 'minimum' maneuver at edge of band (or quantized altitude level).
- Aircraft speeds (non-accelerating): Ownship 150 KGS, Intruder 180 KGS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nmi., no DAA alerts displayed.
- Climb/Roll/Pitch Rates: 0/0/0
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. UAS pilot receives DAA corrective alert with associated guidance
2. UAS pilot maneuvers in response to DAA alert and remains well clear of intruder.
3. DAA alert(s) and guidance are removed once ownship is clear of threat.

Additional Information

FT4 TEST OBJECTIVES – SSIWest.4.b

Objective 4: Validate DAA alerting and guidance requirements in the presence of realistic sensor, tracking and navigational errors: b) nominal speed encounter (unmitigated, >10kft)	**MOPS Sections 2.2.4.2.4 Alerting 2.2.4.3 Determine Processing**

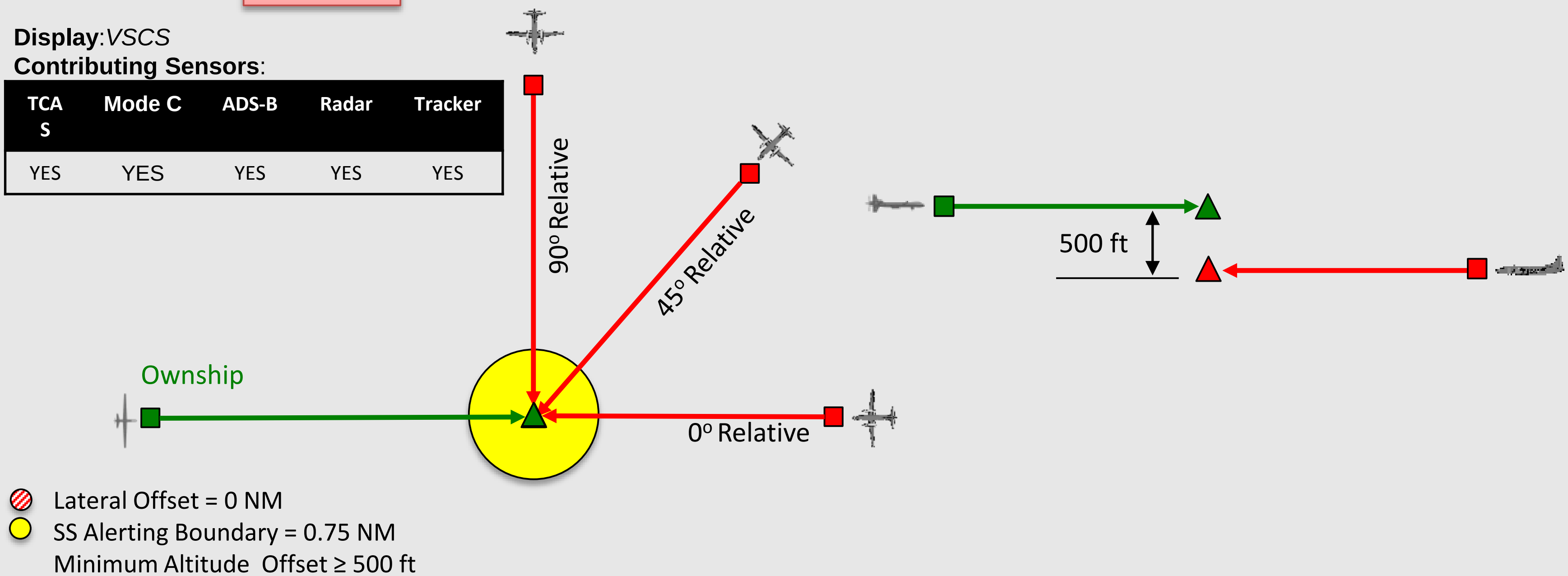
Configuration

System Under Test: Omnibands

Display: *VSCS*

Contributing Sensors:

TCAS	Mode C	ADS-B	Radar	Tracker
YES	YES	YES	YES	YES



Scenario(s): #060-062

Test Objectives (TO)	1. Validate DAA alert timing allows pilot sufficient time to assess options and maneuver to remain well clear. 2. Validate DAA guidance to UAS pilot is appropriate (reasonable, timely & responsive). 3. Validate removal of DAA alert(s) once clear of threat.
Success Criteria (retest if criteria not met)	1. A timely (corrective initially) DAA alert is provided to the UAS pilot. 2. Well Clear Recovery guidance is provided to the UAS pilot prior to CPA. 3. Data collected: LVC log file, SAAProc log files, TCAS log files for ownship and intruder, SAAP file ('raw' surveillance data).
Test Method	• MANUEVER: none. • Aircraft speeds (non-accelerating): Ownship 150 KGS, Intruder 180 KGS • Encounter Length: 2 min (IP to CPA) • Stable Conditions: stable at the IP (2 minutes prior to CPA) • Test Termination Criteria: targets diverging, range > 0.75 nmi., no DAA alerts displayed. • Climb/Roll/Pitch Rates: 0/0/0 • Tolerance: ± 8 sec, ± 5 kts at IP crossing.
Evaluation Criteria (Post-test analysis to determine if test objectives are met)	1. UAS pilot receives DAA corrective alert with associated guidance 2. DAA alert(s) and guidance are removed once ownship is clear of threat. 3. CPA prediction accuracy sufficient for DAA function.
Additional Information	

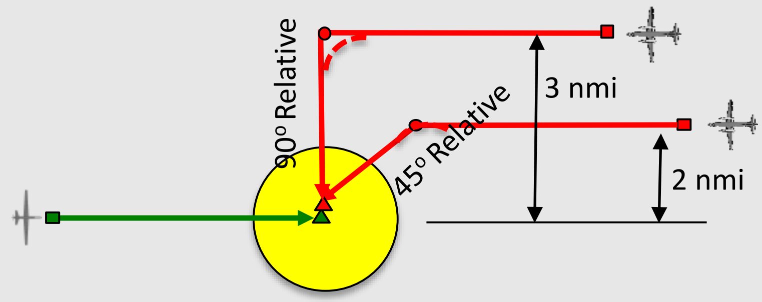
FT4 TEST OBJECTIVES – SSIWest.4.c

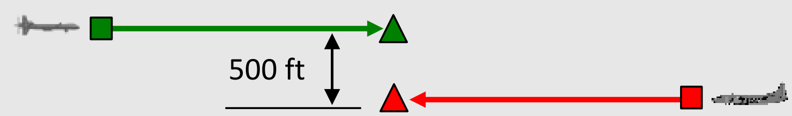
Objective 4: Validate DAA alerting and guidance requirements in the presence of realistic sensor, tracking and navigational errors: c) maneuvering intruder (mitigated, >10kft)	MOPS Sections 2.2.4.2.4 Alerting 2.2.4.3 Determine Processing

Configuration

System Under Test: Omnibands
Display: *VSCS*
Contributing Sensors:

TCAS	Mode C	ADS-B	Radar	Tracker
YES	YES	YES	YES	YES





Scenario(s): #063-064

Lateral Offset = 0 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 500 ft
Initial Intruder Course Lateral Offset: TBD ft.

Test Objectives (TO)

1. Validate DAA alert timing allows pilot sufficient time to assess options and maneuver to remain well clear.
2. Validate DAA guidance to UAS pilot is appropriate (reasonable, timely & responsive).
3. Validate selected DAA maneuver results in remaining well clear, and removal of the alert once clear of threat.

Success Criteria (retest if criteria not met)

1. A timely (corrective initially) DAA alert is provided to the UAS pilot.
2. UAS pilot maneuvers in response to DAA alert.
3. Data collected: LVC log file, SAAProc log files, TCAS log files for ownship and intruder, SAAP file (‘raw’ surveillance data).

Test Method

- MANUEVER: Pilot to manually select and execute ‘minimum’ maneuver at edge of band (or quantized altitude level).
- Aircraft speeds (non-accelerating): Ownship 150 KGS, Intruder 180 KGS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nmi., no DAA alerts displayed.
- Climb/Roll/Pitch Rates: 0/0/0
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. UAS pilot receives DAA corrective alert with associated guidance
2. UAS pilot maneuvers in response to DAA alert and remains well clear of intruder.
3. DAA alert(s) and guidance are removed once ownship is clear of threat.

Additional Information

FT4 TEST OBJECTIVES – SSIWest.4.d

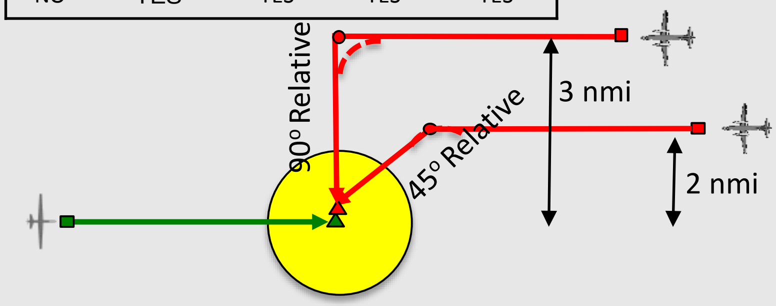
Objective 4: Validate DAA alerting and guidance requirements in the presence of realistic sensor, tracking and navigational errors: d) maneuvering intruder (unmitigated, >10kft)	MOPS Sections 2.2.4.2.4 Alerting 2.2.4.3 Determine Processing

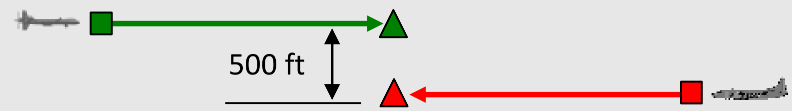
Configuration

System Under Test:
Display:*VSCS*
Contributing Sensors:

Omnibands

TCAS	Mode C	ADS-B	Radar	Tracker
NO	YES	YES	YES	YES





Scenario(s): #065-066

Lateral Offset = 0 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 500 ft
Initial Intruder Course Lateral Offset: TBD ft.

Test Objectives (TO)

1. Validate DAA alert timing allows pilot sufficient time to assess options and maneuver to remain well clear.
2. Validate DAA guidance to UAS pilot is appropriate (reasonable, timely & responsive).
3. Validate removal of DAA alert(s) once clear of threat.

Success Criteria (retest if criteria not met)

1. A timely (corrective initially) DAA alert is provided to the UAS pilot.
2. Well Clear Recovery guidance is provided to the UAS pilot prior to CPA.
3. Data collected: LVC log file, SAAProc log files, TCAS log files for ownship and intruder, SAAP file ('raw' surveillance data).

Test Method

- MANUEVER: none.
- Aircraft speeds (non-accelerating): Ownship 150 KGS, Intruder 180 KGS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nmi., no DAA alerts displayed.
- Climb/Roll/Pitch Rates: 0/0/0
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. UAS pilot receives DAA corrective alert with associated guidance
2. DAA alert(s) and guidance are removed once ownship is clear of threat.
3. CPA prediction accuracy sufficient for DAA function.

Additional Information

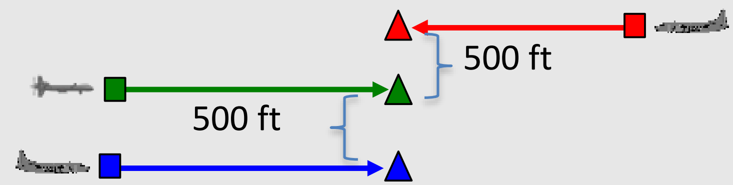
FT4 TEST OBJECTIVES – SSIWest.4.e

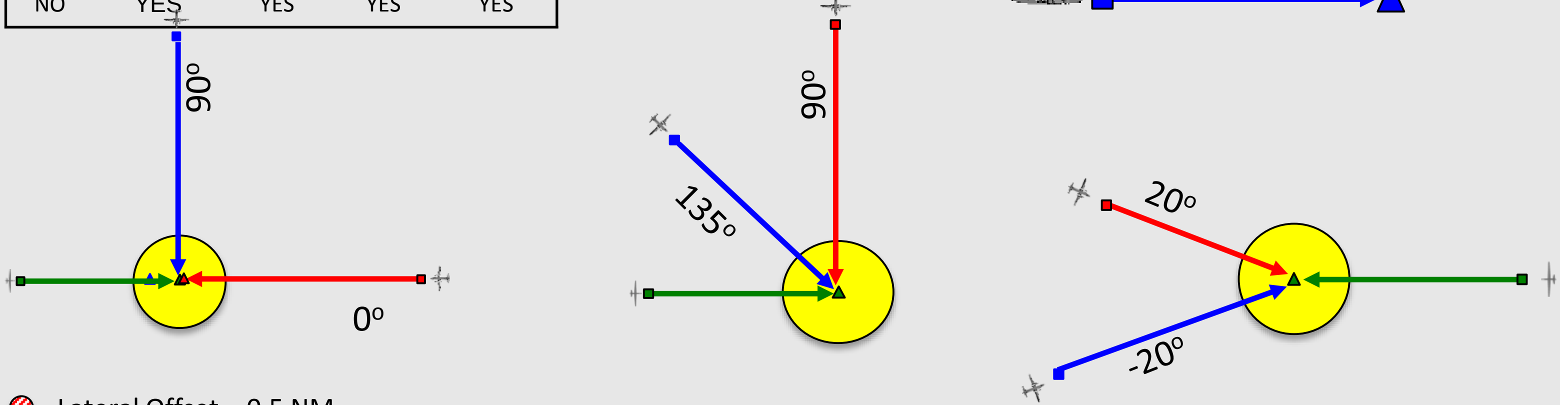
Objective 4: Validate DAA alerting and guidance requirements in the presence of realistic sensor, tracking and navigational errors: e) multiple intruder (mitigated, >10kft)	MOPS Sections 2.2.4.2.4 Alerting 2.2.4.3 Determine Processing

Configuration

System Under Test: **Omnibands**
Display: *VSCS*
Contributing Sensors:

TCAS	Mode C	ADS-B	Radar	Tracker
NO	YES	YES	YES	YES





Scenario(s): #067-069

Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 500 ft

Test Objectives (TO)	1. Validate DAA alert timing allows pilot sufficient time to assess options and maneuver to remain well clear. 2. Validate DAA guidance to UAS pilot is appropriate (reasonable, timely & responsive). 3. Validate selected DAA maneuver results in remaining well clear, and removal of the alert once clear of threat.
Success Criteria (retest if criteria not met)	1. A timely (corrective initially) DAA alert is provided to the UAS pilot. 2. UAS pilot maneuvers in response to DAA alert. 3. Data collected: LVC log file, SAAProc log files, TCAS log files for ownship and intruder, SAAP file (‘raw’ surveillance data).
Test Method	• MANUEVER: Pilot to manually select and execute ‘minimum’ maneuver at edge of band (or quantized altitude level). • Aircraft speeds (non-accelerating): Ownship 150 KGS, Primary Intruder 180 KGS, Secondary Intruder 150 KGS • Encounter Length: 2 min (IP to CPA) • Stable Conditions: stable at the IP (2 minutes prior to CPA) • Test Termination Criteria: targets diverging, range > 0.75 nmi., no DAA alerts displayed. • Climb/Roll/Pitch Rates: 0/0/0 • Tolerance: ± 8 sec, ± 5 kts at IP crossing.
Evaluation Criteria (Post-test analysis to determine if test objectives are met)	1. UAS pilot receives DAA corrective alert with associated guidance 2. UAS pilot maneuvers in response to DAA alert and remains well clear of intruder. 3. DAA alert(s) and guidance are removed once ownship is clear of threat.
Additional Information	

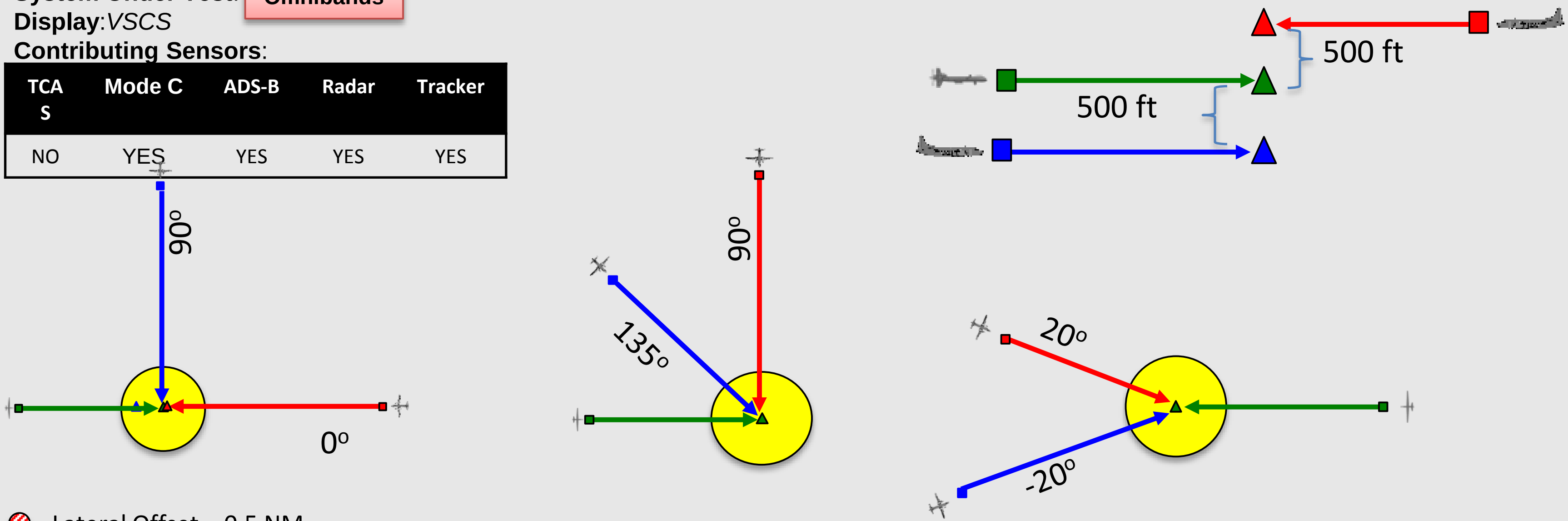
FT4 TEST OBJECTIVES – SSIWest.4.e

Objective 4: Validate DAA alerting and guidance requirements in the presence of realistic sensor, tracking and navigational errors: e) multiple intruder (unmitigated, >10kft)	MOPS Sections 2.2.4.2.4 Alerting 2.2.4.3 Determine Processing

Configuration

System Under Test: Omnibands
Display: *VSCS*
Contributing Sensors:

TCAS	Mode C	ADS-B	Radar	Tracker
NO	YES	YES	YES	YES



Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 500 ft

Scenario(s): #070-072

Test Objectives (TO)

1. Validate DAA alert timing allows pilot sufficient time to assess options and maneuver to remain well clear.
2. Validate DAA guidance to UAS pilot is appropriate (reasonable, timely & responsive).
3. Validate selected DAA maneuver results in remaining well clear, and removal of the alert once clear of threat.

Success Criteria (retest if criteria not met)

1. A timely (corrective initially) DAA alert is provided to the UAS pilot.
2. Data collected: LVC log file, SAAProc log files, TCAS log files for ownship and intruder, SAAP file ('raw' surveillance data).

Test Method

- MANUEVER: none.
- Aircraft speeds (non-accelerating): Ownship 150 KGS, Primary Intruder 180 KGS, Secondary Intruder 150 KGS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nmi., no DAA alerts displayed.
- Climb/Roll/Pitch Rates: 0/0/0
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. UAS pilot receives DAA corrective alert with associated guidance
2. DAA alert(s) and guidance are removed once ownship is clear of threat.
3. CPA prediction accuracy sufficient for DAA function.

Additional Information

Additional (lower priority) encounters

FT4 TEST OBJECTIVES – SSIWest.1.h

Objective 1: Validate DAA requirements in stressing cases that drive MOPS requirements: (h) high vertical closure rate encounter (unmitigated, >10kft MSL)

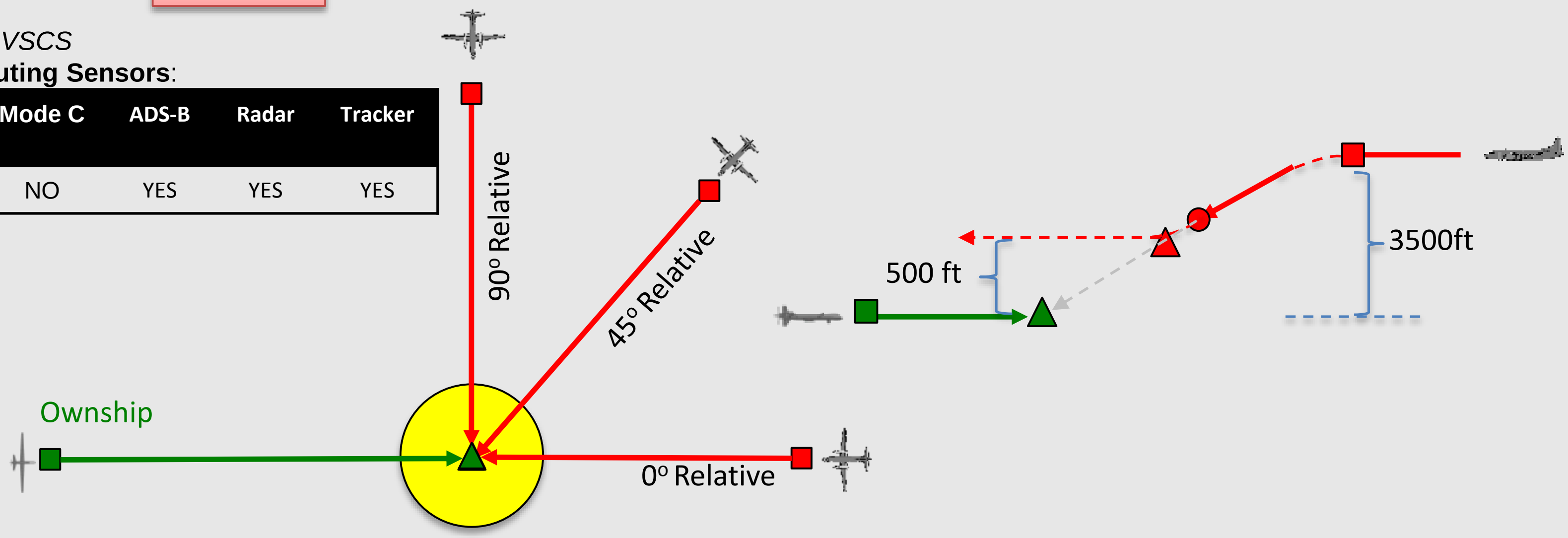
<MOPS reference>

Configuration

System Under Test: **Omnibands**

Display:*VSCS*
Contributing Sensors:

TCAS	Mode C	ADS-B	Radar	Tracker
NO	NO	YES	YES	YES



Lateral Offset = 0 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 500 ft

Test Objectives (TO)

1. Validate DAA alert timing allows pilot sufficient time to assess options and maneuver to remain well clear.
2. Validate DAA guidance to UAS pilot is appropriate (reasonable, timely & responsive).
3. Validate removal of DAA alert(s) once clear of threat.

Success Criteria (retest if criteria not met)

1. A timely (corrective initially) DAA alert is provided to the UAS pilot.
2. A timely DAA warning alert is provided to the UAS pilot prior to CPA.
3. Data collected: LVC log file, SAAProc log files, TCAS log files for ownship and intruder, SAAP file ('raw' surveillance data).

Test Method

- MANUEVER: none.
- Aircraft speeds (non-accelerating): Ownship 150 KTAS, Intruder 180 KTAS
- Encounter Length: 1 min (IP to CPA)
- Stable Conditions: stable at the IP (1 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nmi., no DAA alerts displayed.
- Climb/Roll/Pitch Rates: Ownship 0/0/0, Intruder -2500FPM/0/0
- Tolerance: ± 8 sec, ± 5 kts, ±100 FPM at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. UAS pilot receives DAA corrective alert with associated guidance
2. DAA alert(s) and guidance are removed once ownship is clear of threat.
3. CPA prediction accuracy sufficient for DAA function.

Additional Information

SSI-INTERNAL: This is very similar to the single intruder TCAS interoperability encounter with high vertical closure rate. This should be assessed as

FT4 TEST OBJECTIVES – SSIWest.1.i

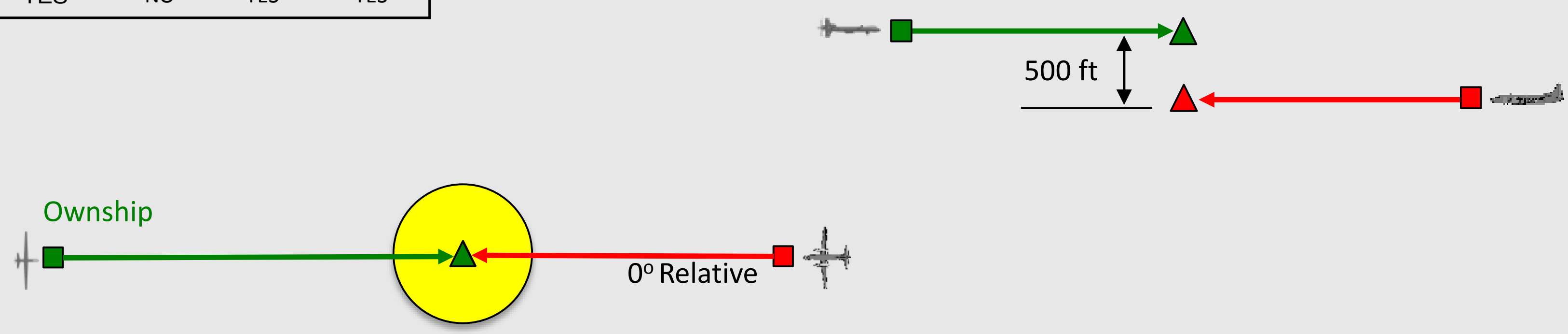
Objective 1: Validate DAA requirements in stressing cases that drive MOPS requirements: (i) Mode C only intruder (mitigated, <10kft MSL) — ***<MOPS reference>***

Configuration

System Under Test: **Omnibands**

Display: *VSCS*
Contributing Sensors:

TCAS	Mode C	ADS-B	Radar	Tracker
NO	YES	NO	YES	YES



Lateral Offset = 0 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 500 ft

Test Objectives (TO)

1. Validate DAA alert timing allows pilot sufficient time to assess options and maneuver to remain well clear.
2. Validate DAA guidance to UAS pilot is appropriate (reasonable, timely & responsive).
3. Validate selected DAA maneuver results in remaining well clear, and removal of the alert once clear of threat.

Success Criteria (retest if criteria not met)

1. A timely (corrective initially) DAA alert is provided to the UAS pilot.
2. UAS pilot maneuvers in response to DAA alert.
3. Data collected: LVC log file, SAAProc log files, TCAS log files for ownship and intruder, SAAP file (‘raw’ surveillance data).

Test Method

- MANUEVER: Pilot to manually select and execute ‘minimum’ maneuver at edge of band (or quantized altitude level).
- Aircraft speeds (non-accelerating): Ownship 150 KTAS, Intruder 150/180/210 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nmi., no DAA alerts displayed.
- Climb/Roll/Pitch Rates: 0/0/0
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. UAS pilot receives DAA corrective alert with associated guidance
2. UAS pilot maneuvers in response to DAA alert and remains well clear of intruder.
3. DAA alert(s) and guidance are removed once ownship is clear of threat.

Additional Information

SSI-INTERNAL: Unclear if this geometry is of any utility in flight test… radar tracks are provided to the fusion tracker usually far beyond RDR… as

FT4 TEST OBJECTIVES – SSIWest.1.j

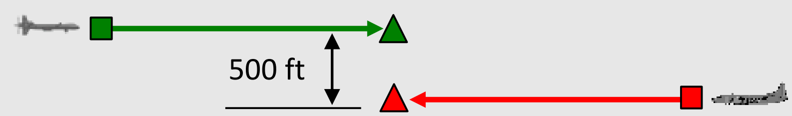
Objective 1: Validate DAA requirements in stressing cases that drive MOPS requirements: (j) Mode C only intruder (unmitigated, <10kft MSL)	<MOPS reference>

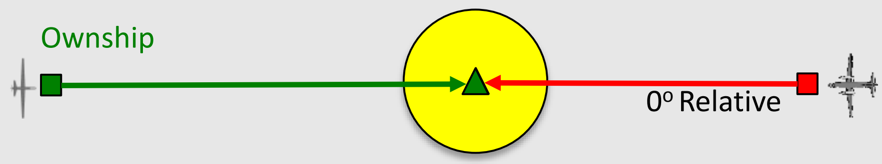
Configuration

System Under Test: **Omnibands**

Display: *VSCS*
Contributing Sensors:

TCAS	Mode C	ADS-B	Radar	Tracker
NO	YES	NO	YES	YES





Lateral Offset = 0 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 500 ft

Test Objectives (TO)

1. Validate DAA alert timing allows pilot sufficient time to assess options and maneuver to remain well clear.
2. Validate DAA guidance to UAS pilot is appropriate (reasonable, timely & responsive).
3. Validate removal of DAA alert(s) once clear of threat.

Success Criteria (retest if criteria not met)

1. A timely (corrective initially) DAA alert is provided to the UAS pilot.
2. Well Clear Recovery guidance is provided to the UAS pilot prior to CPA.
3. Data collected: LVC log file, SAAProc log files, TCAS log files for ownship and intruder, SAAP file (‘raw’ surveillance data).

Test Method

- MANUEVER: none.
- Aircraft speeds (non-accelerating): Ownship 150 KTAS, Intruder 150/180/210 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nmi., no DAA alerts displayed.
- Climb/Roll/Pitch Rates: 0/0/0
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. UAS pilot receives DAA corrective alert with associated guidance
2. DAA alert(s) and guidance are removed once ownship is clear of threat.
3. CPA prediction accuracy sufficient for DAA function.

Additional Information

UAS in the NAS
FT4 Test Objectives
(DAIDALUS)

DAIDALUS MOPS Traceback

The sections in the MOPS we will be validating for FT4 are as follows:

- 2.2.4.2.1 DAA Well Clear Definition
- 2.2.4.3 Determine Processing
- 2.2.4.4 Collision Avoidance Interoperability

- Appendix D. UAS Maneuver Requirements
- Appendix G. DAA Alerting Logic Reference Implementation

Although we are not validating the sensors themselves, we are characterizing how the sensors impact state estimation, include 2.2.3 DAA Surveillance Subsystem

Fly Through

TEST OBJECTIVES

Demonstrate performance in a Head-on scenario. | **Section A.5.1 DAA MOPS / Version: July 28, 2015**

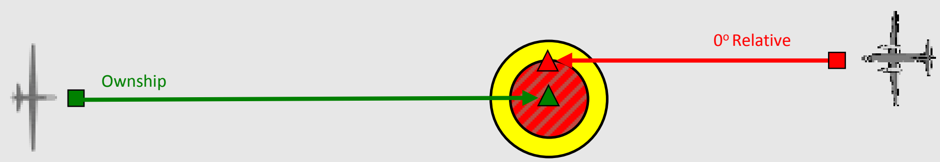
Configuration

S1

System Under Test: DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES



	Altitude
UAS	10000ft-20000ft
INT	10000ft-20000ft

Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 300 ft

Scenario(s): #073

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting to the UAS in a head-on scenario
2. SAA fusion processor correctly correlates tracks
3. Establish baseline for DAIDALUS

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the head-on intruder aircraft. DAIDALUS Display provides the following:
- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track

Test Method

- MANEUVER –*NO*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Climb Rate: 0
- Roll Rate: 0
- Pitch Rate: 0
- Tolerance: ± 10 sec
- Ownship: 150-180kgs
- Intruder: 150-180kgs

Success Criteria

- Data collected from MACS display (see data requirements)

Expected Results

Ownship alerting
- Progress through each DAA alerting condition

Additional Information

Do not follow guidance. Follow predescribed path, hold constant altitude and speed.
The closest point of approach (CPA) is 0.5NM

TEST OBJECTIVES

Demonstrate performance in Front-Quartering scenario. | **Section A.5.1 DAA MOPS / Version: July 28, 2015**

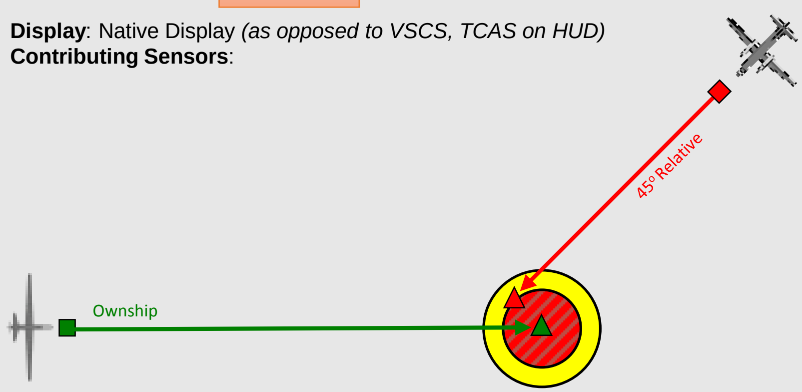
Configuration

System Under Test: DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES

S2



Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 300 ft

	Altitude
UAS	10000ft-20000ft
INT	10000ft-20000ft

Scenario(s): #074

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting to the UAS in a head-on scenario
2. SAA fusion processor correctly correlates tracks
3. Establish baseline for DAIDALUS

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:
- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track

Test Method

- MANEUVER –*NO*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Climb Rate:
- Roll Rate:
- Pitch Rate:
- Tolerance: ± 10 sec
- Ownship: 150-180kgs
- Intruder: 150-180kgs

Success Criteria

- Data collected from MACS display (see data requirements)

Expected Results

Ownship alerting
- Progress through each alerting condition

Additional Information

Do not follow guidance. Follow predescribed path, hold constant altitude and speed.
The closest point of approach (CPA) is 0.5NM

TEST OBJECTIVES

Demonstrate performance in Crossing scenario.	Section A.5.1 DAA MOPS / Version: July 28, 2015

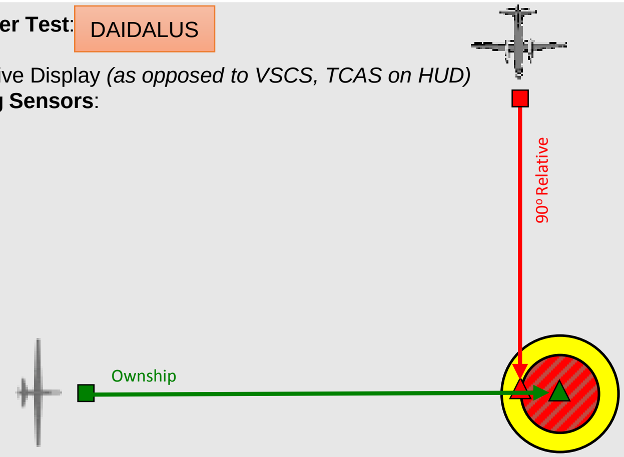
Configuration

System Under Test: DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES

S3



Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 300 ft

	Altitude
UAS	10000ft-20000ft
INT	10000ft-20000ft

Scenario(s): #075

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting to the UAS in a crossing scenario
2. SAA fusion processor correctly correlates tracks

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the crossing intruder aircraft. DAIDALUS Display provides the following:

- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track

Test Method

- MANEUVER –*NO*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Climb Rate:
- Roll Rate:
- Pitch Rate:
- Tolerance: ± 10 sec
- Ownship: 150-180kgs
- Intruder: 150-180kgs

Success Criteria

- Data collected from MACS display (see data requirements)

Expected Results

Ownship alerting

- Progress through each alerting condition

Additional Information

Do not follow guidance. Follow predescribed path, hold constant altitude and speed.
The closest point of approach (CPA) is 0.5NM

TEST OBJECTIVES

Demonstrate performance in Rear-Quartering scenario.

Section A.5.1 DAA MOPS / Version: July 28, 2015

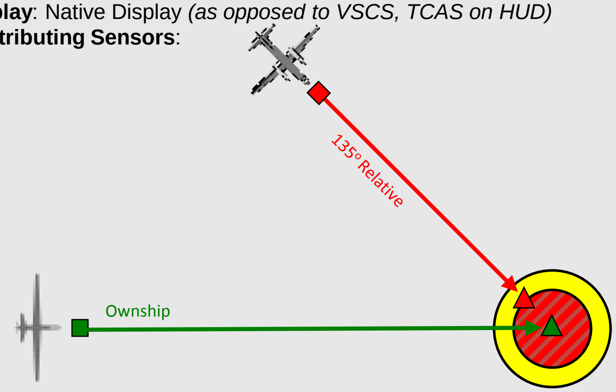
S4

Configuration

System Under Test: DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES



Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 300 ft

	Altitude
UAS	10000ft-20000ft
INT	10000ft-20000ft

Scenario(s): #076

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting to the UAS in a rear-quartering scenario
2. SAA fusion processor correctly correlates tracks

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the head-on intruder aircraft. DAIDALUS Display provides the following:

- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track

Test Method

- MANEUVER –*NO*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Climb Rate:
- Roll Rate:
- Pitch Rate:
- Tolerance: ± 10 sec
- Ownship: 150-180kgs
- Intruder: 150-180kgs

Success Criteria

- Data collected from MACS display (see data requirements)

Expected Results

Ownship alerting

- Progress through each alerting condition

Additional Information

Do not follow guidance. Follow predescribed path, hold constant altitude and speed.
The closest point of approach (CPA) is 0.5NM

TEST OBJECTIVES

Demonstrate performance in an Overtaking scenario. | **Section A.5.1 DAA MOPS / Version: July 28, 2015**

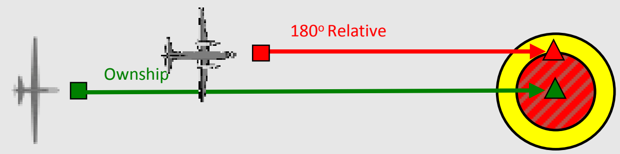
Configuration

System Under Test: DAIDALUS

S5

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES



	Altitude
UAS	10000ft-20000ft
INT	10000ft-20000ft

Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 300 ft

Scenario(s): #077

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting to the UAS in an overtaking scenario
2. SAA fusion processor correctly correlates tracks

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the overtaken intruder aircraft. DAIDALUS Display provides the following:

- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track

Test Method

- MANEUVER –*NO*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Climb Rate:
- Roll Rate:
- Pitch Rate:
- Tolerance: ± 10 sec
- Ownship: 150-180kgs
- Intruder: 150-180kgs

Success Criteria

- Data collected from MACS display (see data requirements)

Expected Results

Ownship alerting

- Progress through each alerting condition

Additional Information

Do not follow guidance. Follow predescribed path, hold constant altitude and speed.
The closest point of approach (CPA) is 0.5NM

TEST OBJECTIVES

Demonstrate performance in a Head-on scenario. | **Section A.5.1 DAA MOPS / Version: July 28, 2015**

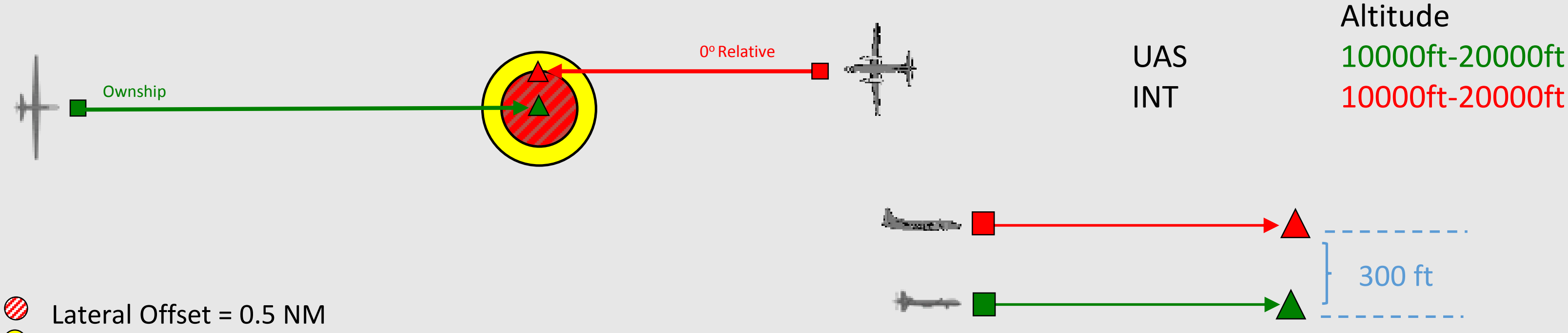
Configuration

System Under Test: DAIDALUS

S6

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	NO	YES	YES



Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 300 ft

Scenario(s): #078

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting to the UAS in a head-on scenario
2. SAA fusion processor correctly correlates tracks

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the head-on intruder aircraft. DAIDALUS Display provides the following:
- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track

Test Method

- MANEUVER –*NO*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Climb Rate:
- Roll Rate:
- Pitch Rate:
- Tolerance: ± 10 sec
- Ownship: 150-180kgs
- Intruder: 150-180kgs

Success Criteria

- Data collected from MACS display (see data requirements)

Expected Results

Ownship alerting
- Progress through each alerting condition

Additional Information

Do not follow guidance. Follow predescribed path, hold constant altitude and speed.
The closest point of approach (CPA) is 0.5NM

TEST OBJECTIVES

Demonstrate performance in Front-Quartering scenario.	Section A.5.1 DAA MOPS / Version: July 28, 2015

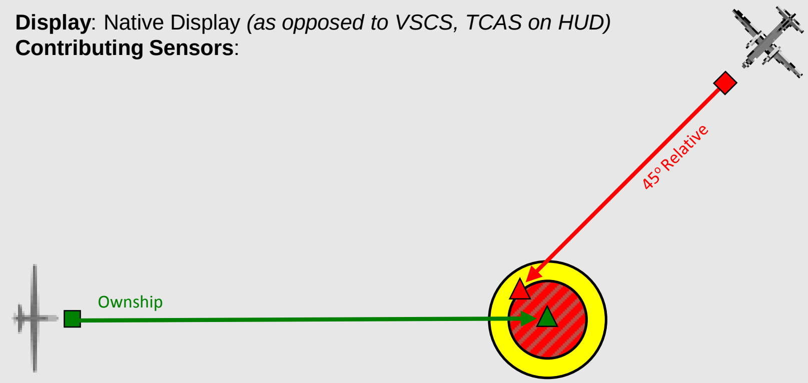
Configuration

System Under Test: DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	NO	YES	YES

S7



	Altitude
UAS	10000ft-20000ft
INT	10000ft-20000ft

Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 300 ft

Scenario(s): #079

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting to the UAS in a front quartering scenario
2. SAA fusion processor correctly correlates tracks

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the head-on intruder aircraft. DAIDALUS Display provides the following:

- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track

Test Method

- MANEUVER –*NO*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Climb Rate:
- Roll Rate:
- Pitch Rate:
- Tolerance: ± 10 sec
- Ownship: 150-180kgs
- Intruder: 150-180kgs

Success Criteria

- Data collected from MACS display (see data requirements)

Expected Results

Ownship alerting

- Progress through each alerting condition

Additional Information

Do not follow guidance. Follow predescribed path, hold constant altitude and speed.
The closest point of approach (CPA) is 0.5NM

TEST OBJECTIVES

Demonstrate performance in Crossing scenario. | **Section A.5.1 DAA MOPS / Version: July 28, 2015**

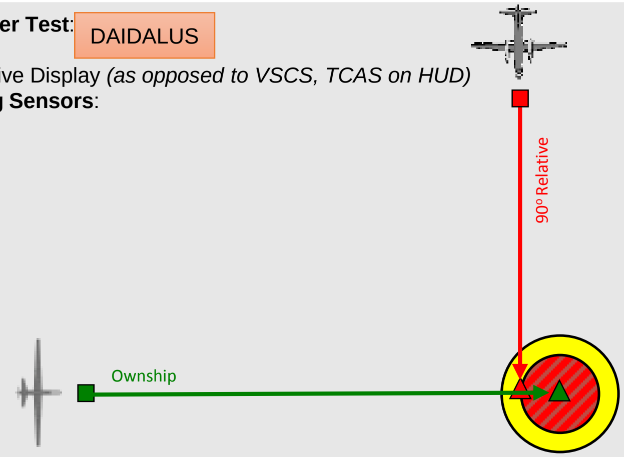
S8

Configuration

System Under Test: DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	NO	YES	YES



	Altitude
UAS	10000ft-20000ft
INT	10000ft-20000ft

Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 300 ft

Scenario(s): #080

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting to the UAS in a crossing scenario
2. SAA fusion processor correctly correlates tracks

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the head-on intruder aircraft. DAIDALUS Display provides the following:

- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track

Test Method

- MANEUVER –*NO*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Climb Rate:
- Roll Rate:
- Pitch Rate:
- Tolerance: ± 10 sec
- Ownship: 150-180kgs
- Intruder: 150-180kgs

Success Criteria

- Data collected from MACS display (see data requirements)

Expected Results

Ownship alerting

- Progress through each alerting condition

Additional Information

Do not follow guidance. Follow predescribed path, hold constant altitude and speed.
The closest point of approach (CPA) is 0.5NM

Ownship Vertical Maneuvers

TEST OBJECTIVES

Demonstrate performance in a Head-on scenario. | **Section A.5.1 DAA MOPS / Version: July 28, 2015**

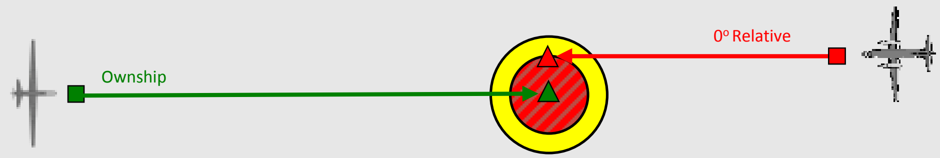
Configuration

System Under Test DAIDALUS

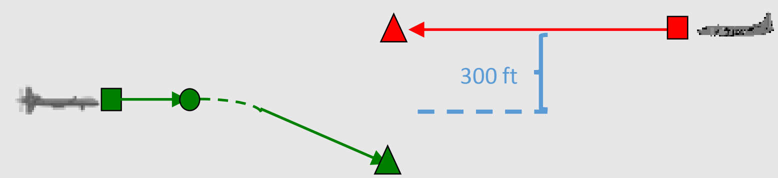
S17

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES



	Altitude
UAS	10000ft-20000ft
INT	10000ft-20000ft



Scenario(s): #083

Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 300 ft

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct guidance
2. SAA fusion processor correctly correlates tracks
3. Determine suitability of sensor for vertical guidance

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:
- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track
- ALT and VS bands provide vertical separation solution

Test Method

- MANEUVER – *Follow ALT or VS bands*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Roll Rate:
- Pitch Rate:
- Tolerance: ± 10 sec
- Spped: Own-150-180kgs, Intruder-150-180kgs
- Vertical Speed: 500-1000fpm

Success Criteria

- UAS Maneuvers away from intruder to remain well clear
- Alerting progress from each alerting level
- Data collected at the LVC (Time Synced)

Expected Results

Ownship alerting
- Progress through each alerting condition
- Ownship maneuvers away from encounter then maneuvers back to course

Additional Information

Follow Alt or VS bands to avoid intruder.
The closest point of approach (CPA) is 0.5NM

TEST OBJECTIVES

Demonstrate DAIDALUS vertical guidance during a Front-Quartering scenario.

Section A.5.1 DAA MOPS / Version: July 28, 2015

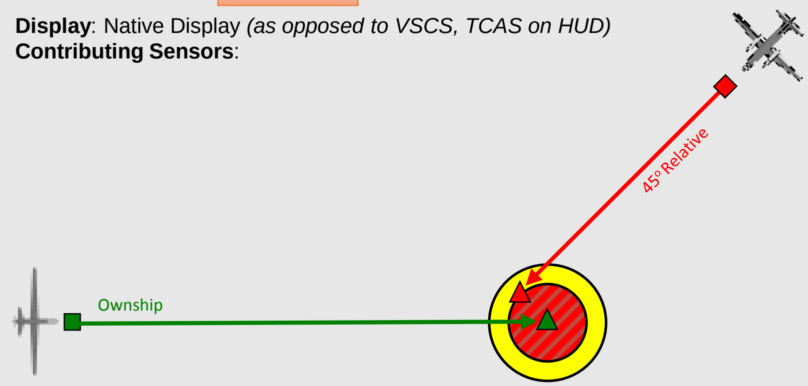
Configuration

S18

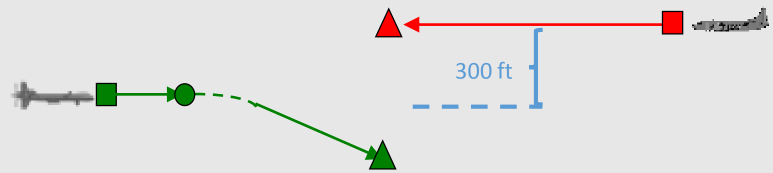
System Under Test: DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES



	Altitude
UAS	10000ft-20000ft
INT	10000ft-20000ft



Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 400 ft

Scenario(s): #084

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct guidance
2. SAA fusion processor correctly correlates tracks
3. Determine suitability of sensor for vertical guidance

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:

- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track
- ALT and VS bands provide vertical separation solution

Test Method

- MANEUVER – *Follow ALT or VS bands*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Roll Rate:
- Pitch Rate:
- Tolerance: ± 10 sec
- Spped: Own-150-180kgs, Intruder-150-180kgs
- Vertical Speed: 500-1000fpm

Success Criteria

- UAS Maneuvers away from intruder to remain well clear
- Alerting progress from each alerting level
- Data collected at the LVC (Time Synced)

Expected Results

Ownship alerting

- Progress through each alerting condition
- Ownship maneuvers away from encounter then maneuvers back to course

Additional Information

Follow Alt or VS bands to avoid intruder.
The closest point of approach (CPA) is 0.5NM

TEST OBJECTIVES

Demonstrate DAIDALUS vertical guidance during a Crossing scenario.	Section A.5.1 DAA MOPS / Version: July 28, 2015

Configuration

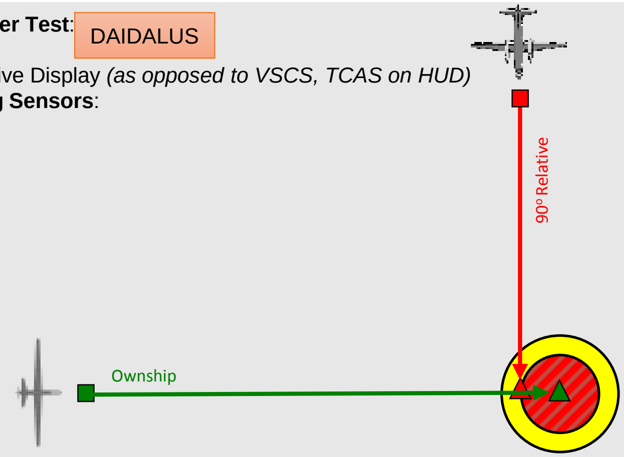
System Under Test: DAIDALUS

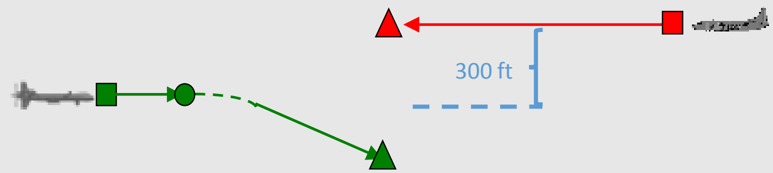
Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES

S19

	Altitude
UAS	10000ft-20000ft
INT	10000ft-20000ft





Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 400 ft

Scenario(s): #085

Test Objective (TO)	1. The DAIDALUS algorithm as displayed on the native display will show the correct guidance 2. SAA fusion processor correctly correlates tracks 3. Determine suitability of sensor for vertical guidance
Evaluation Criteria	The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following: • TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA… • TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track • ALT and VS bands provide vertical separation solution
Test Method	• MANEUVER – *Follow ALT or VS bands* • Encounter Length: 3 min • Stable Conditions: 2.5 min before CPA • Roll Rate: • Pitch Rate: • Tolerance: ± 10 sec • Spped: Own-150-180kgs, Intruder-150-180kgs • Vertical Speed: 500-1000fpm
Success Criteria	• UAS Maneuvers away from intruder to remain well clear • Alerting progress from each alerting level • Data collected at the LVC (Time Synced)
Expected Results	Ownship alerting • Progress through each alerting condition • Ownship maneuvers away from encounter then maneuvers back to course
Additional Information	Follow Alt or VS bands to avoid intruder. The closest point of approach (CPA) is 0.5NM

TEST OBJECTIVES

Demonstrate DAIDALUS vertical guidance during a Rear-Quartering scenario.	Section A.5.1 DAA MOPS / Version: July 28, 2015

Configuration

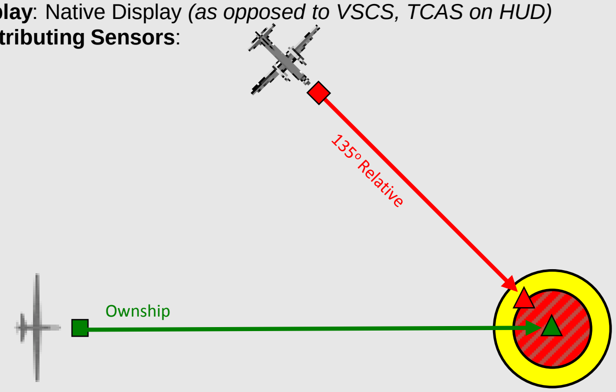
System Under Test DAIDALUS

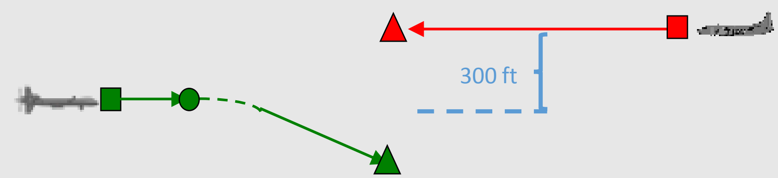
Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES

S20

	Altitude
UAS	10000ft-20000ft
INT	10000ft-20000ft





Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 300 ft

Scenario(s): #086

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct guidance
2. SAA fusion processor correctly correlates tracks
3. Determine suitability of sensor for vertical guidance

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:
- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track
- ALT and VS bands provide vertical separation solution

Test Method

- MANEUVER – *Follow ALT or VS bands*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Roll Rate:
- Pitch Rate:
- Tolerance: ± 10 sec
- Spped: Own-150-180kgs, Intruder-150-180kgs
- Vertical Speed: 500-1000fpm

Success Criteria

- UAS Maneuvers away from intruder to remain well clear
- Alerting progress from each alerting level
- Data collected at the LVC (Time Synced)

Expected Results

Ownship alerting
- Progress through each alerting condition
- Ownship maneuvers away from encounter then maneuvers back to course

Additional Information

Follow Alt or VS bands to avoid intruder.
The closest point of approach (CPA) is 0.5NM

TEST OBJECTIVES

Demonstrate DAIDALUS vertical guidance during a Head-on scenario. | **Section A.5.1 DAA MOPS / Version: July 28, 2015**

S21

Configuration

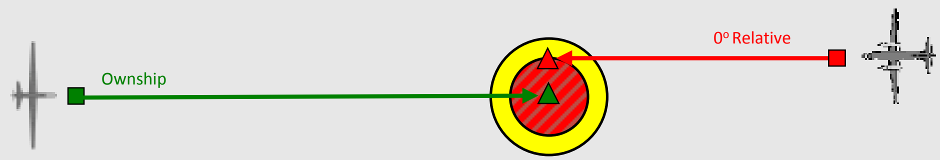
System Under Test: DAIDALUS

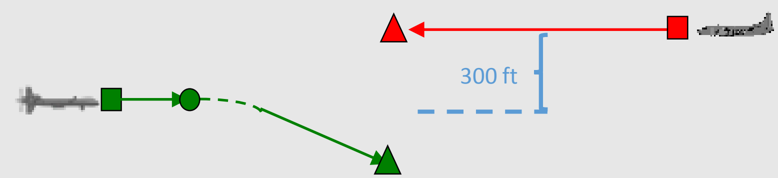
Display: Native Display *(as opposed to VSCS, TCAS on HUD)*

Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	NO	YES	YES

	Altitude
UAS	10000ft-20000ft
INT	10000ft-20000ft





Lateral Offset = 0.5 NM

SS Alerting Boundary = 0.75 NM

Minimum Altitude Offset ≥ 300 ft

Scenario(s): #087

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct guidance
2. SAA fusion processor correctly correlates tracks
3. Determine suitability of sensor for vertical guidance

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:

- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track
- ALT and VS bands provide vertical separation solution

Test Method

- MANEUVER – *Follow ALT or VS bands*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Roll Rate:
- Pitch Rate:
- Tolerance: ± 10 sec
- Spped: Own-150-180kgs, Intruder-150-180kgs
- Vertical Speed: 500-1000fpm

Success Criteria

- UAS Maneuvers away from intruder to remain well clear
- Alerting progress from each alerting level
- Data collected at the LVC (Time Synced)

Expected Results

Ownship alerting

- Progress through each alerting condition
- Ownship maneuvers away from encounter then maneuvers back to course

Additional Information

Follow Alt or VS bands to avoid intruder.

The closest point of approach (CPA) is 0.5NM

TEST OBJECTIVES

Demonstrate DAIDALUS vertical guidance during a Front-Quartering scenario.	Section A.5.1 DAA MOPS / Version: July 28, 2015

Configuration

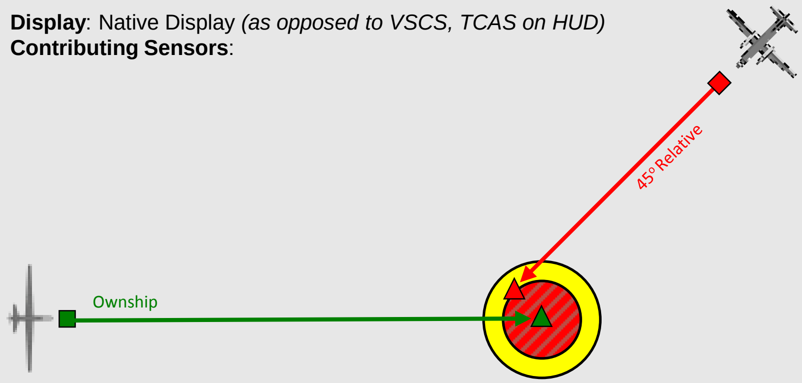
System Under Test: DAIDALUS

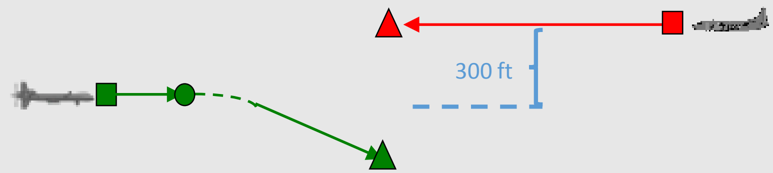
Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	NO	YES	YES

S22

	Altitude
UAS	10000ft-20000ft
INT	10000ft-20000ft





Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 400 ft

Scenario(s): #088

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct guidance
2. SAA fusion processor correctly correlates tracks
3. Determine suitability of sensor for vertical guidance

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:

- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track
- ALT and VS bands provide vertical separation solution

Test Method

- MANEUVER – *Follow ALT or VS bands*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Roll Rate:
- Pitch Rate:
- Tolerance: ± 10 sec
- Spped: Own-150-180kgs, Intruder-150-180kgs
- Vertical Speed: 500-1000fpm

Success Criteria

- UAS Maneuvers away from intruder to remain well clear
- Alerting progress from each alerting level
- Data collected at the LVC (Time Synced)

Expected Results

Ownship alerting

- Progress through each alerting condition
- Ownship maneuvers away from encounter then maneuvers back to course

Additional Information

Follow Alt or VS bands to avoid intruder.
The closest point of approach (CPA) is 0.5NM

TEST OBJECTIVES

Demonstrate DAIDALUS vertical guidance during a Crossing scenario.	Section A.5.1 DAA MOPS / Version: July 28, 2015

Configuration

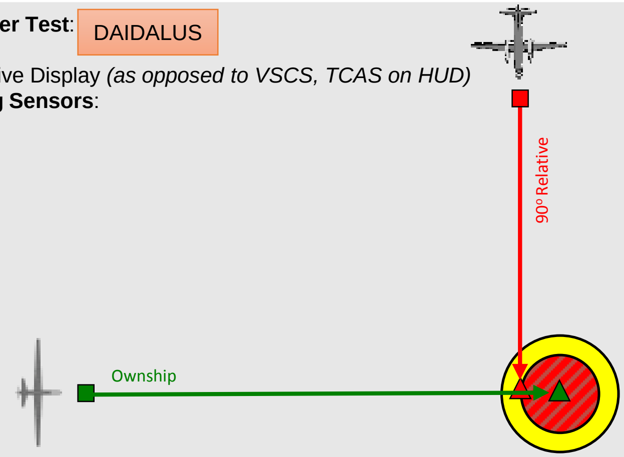
System Under Test: DAIDALUS

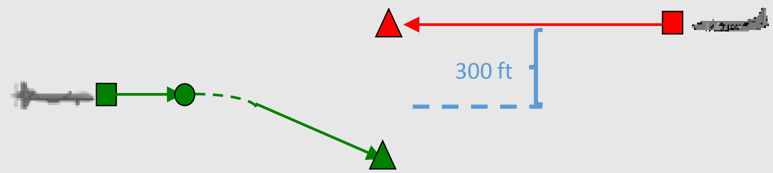
Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	NO	YES	YES

S23

	Altitude
UAS	10000ft-20000ft
INT	10000ft-20000ft





Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 400 ft

Scenario(s): #089

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct guidance
2. SAA fusion processor correctly correlates tracks
3. Determine suitability of sensor for vertical guidance

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:
- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track
- ALT and VS bands provide vertical separation solution

Test Method

- MANEUVER – *Follow ALT or VS bands*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Roll Rate:
- Pitch Rate:
- Tolerance: ± 10 sec
- Spped: Own-150-180kgs, Intruder-150-180kgs
- Vertical Speed: 500-1000fpm

Success Criteria

- UAS Maneuvers away from intruder to remain well clear
- Alerting progress from each alerting level
- Data collected at the LVC (Time Synced)

Expected Results

Ownship alerting
- Progress through each alerting condition
- Ownship maneuvers away from encounter then maneuvers back to course

Additional Information

Follow Alt or VS bands to avoid intruder.
The closest point of approach (CPA) is 0.5NM

Horizontal Blocking Intruder

TEST OBJECTIVES

Demonstrate that DAIDALUS will not guide UAS horizontally into path of another known intruder.

Section A.5.1 DAA MOPS / Version: July 28, 2015

Configuration

S25

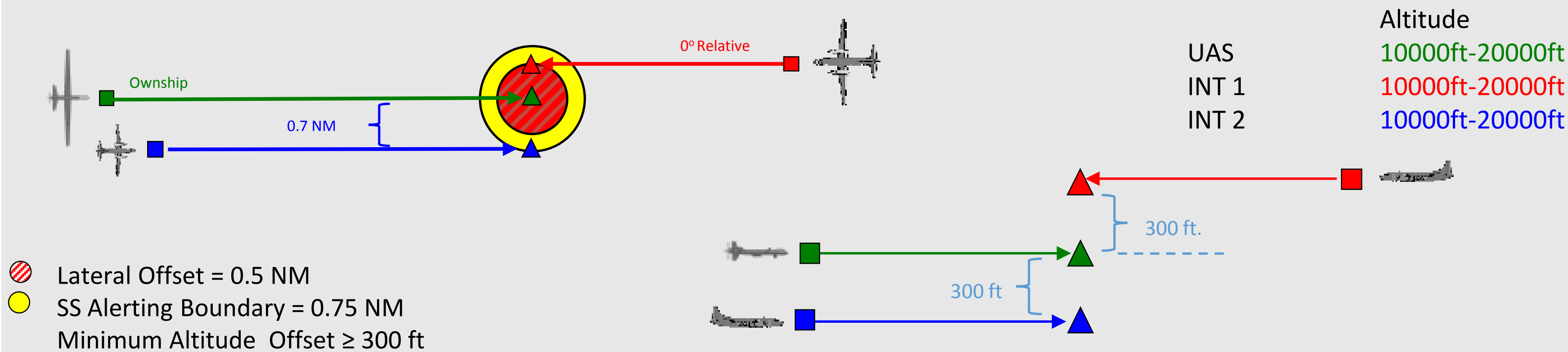
Scenario(s): #091

System Under Test: DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*

Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES



Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct guidance to the UAS - provides solution away from primary and secondary intruders
2. SAA fusion processor correctly correlates tracks

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the head-on intruder aircraft. DAIDALUS Display provides the following:

- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track
- DAIDALUS does not guide the operator into a secondary encounter

Test Method

- MANEUVER –*Follow ALT/VS/Heading bands*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec
- Speed: 150-180kgs
- Vertical Speed: 500-1000fpm

Success Criteria

- Alerting progress from each alerting level
- Data collected at the LVC (Time Synced)

Expected Results

Ownship alerting

- Progress through each alerting condition

Additional Information

Follow heading bands to avoid intruder
The closest point of approach (CPA) for intruder 1 is 0.5NM.
Intruder 2 should be on parallel path at a range of .7nm-1nm at same GS

TEST OBJECTIVES

Demonstrate that DAIDALUS will not guide UAS horizontally into path of another known intruder. | **Section A.5.1 DAA MOPS / Version: July 28, 2015**

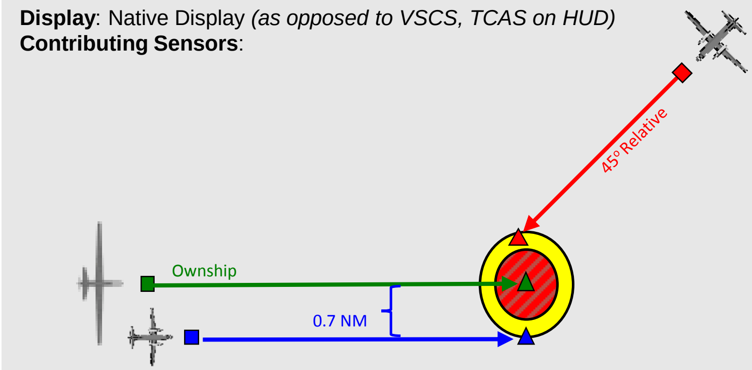
S26

Configuration

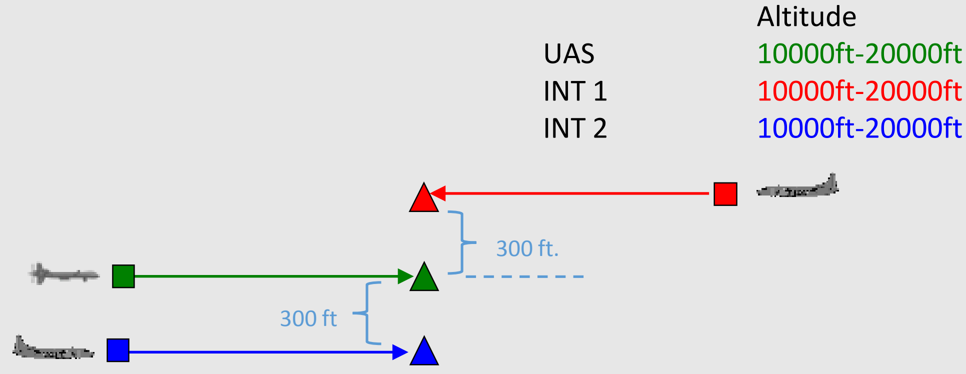
System Under Test: DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES



Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 400 ft



Scenario(s): #092

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct guidance to the UAS - provides solution away from primary and secondary intruders
2. SAA fusion processor correctly correlates tracks

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the head-on intruder aircraft. DAIDALUS Display provides the following:

- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track
- DAIDALUS does not guide the operator into a secondary encounter

Test Method

- MANEUVER –*Follow ALT/VS/Heading bands*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec
- Speed: 150-180kgs
- Vertical Speed: 500-1000fpm

Success Criteria

- Alerting progress from each alerting level
- Data collected at the LVC (Time Synced)

Expected Results

Ownship alerting

- Progress through each alerting condition
- Ownship maneuvers away from encounter prior to TCAS-RA and then maneuvers back to course

Show images of expected alerting

Additional Information

Follow heading bands to avoid intruder
The closest point of approach (CPA) is 0.5NM

TEST OBJECTIVES

Demonstrate that DAIDALUS will not guide UAS horizontally into path of another known intruder.	Section A.5.1 DAA MOPS / Version: July 28, 2015

S27

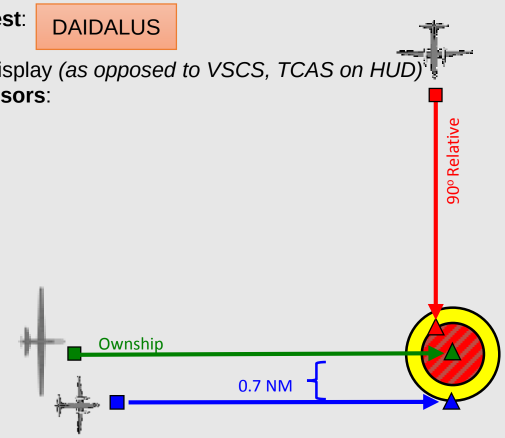
Configuration

System Under Test: DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*

Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES

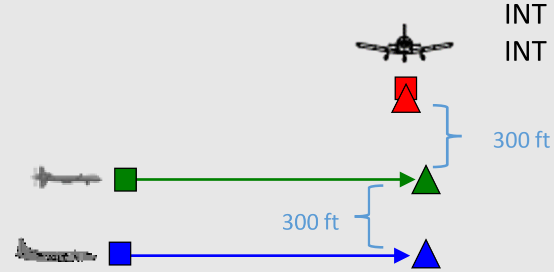


Lateral Offset = 0.5 NM

SS Alerting Boundary = 0.75 NM

Minimum Altitude Offset ≥ 400 ft

	Altitude
UAS	10000ft-20000ft
INT 1	10000ft-20000ft
INT 2	10000ft-20000ft



Scenario(s): #093

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct guidance to the UAS - provides solution away from primary and secondary intruders
2. SAA fusion processor correctly correlates tracks

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the head-on intruder aircraft. DAIDALUS Display provides the following:

- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track
- DAIDALUS does not guide the operator into a secondary encounter

Test Method

- MANEUVER *–Follow ALT/VS/Heading bands*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec
- Speed: 150-180kgs
- Vertical Speed: 500-1000fpm

Success Criteria

- Alerting progress from each alerting level
- Data collected at the LVC (Time Synced)

Expected Results

Ownship alerting

- Progress through each alerting condition
- Ownship maneuvers away from encounter prior to TCAS-RA and then maneuvers back to course

Show images of expected alerting

Additional Information

Follow heading bands to avoid intruder

The closest point of approach (CPA) is 0.5NM

TEST OBJECTIVES

Demonstrate that DAIDALUS will not guide UAS horizontally into path of another known intruder.

Section A.5.1 DAA MOPS / Version: July 28, 2015

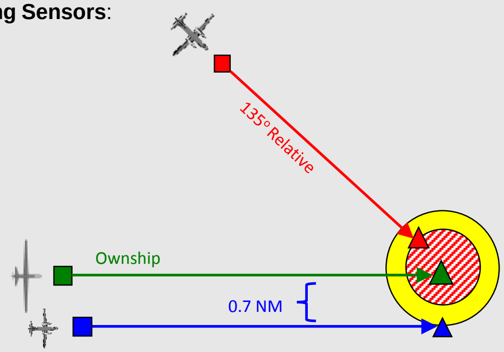
Configuration

System Under Test: DAIDALUS

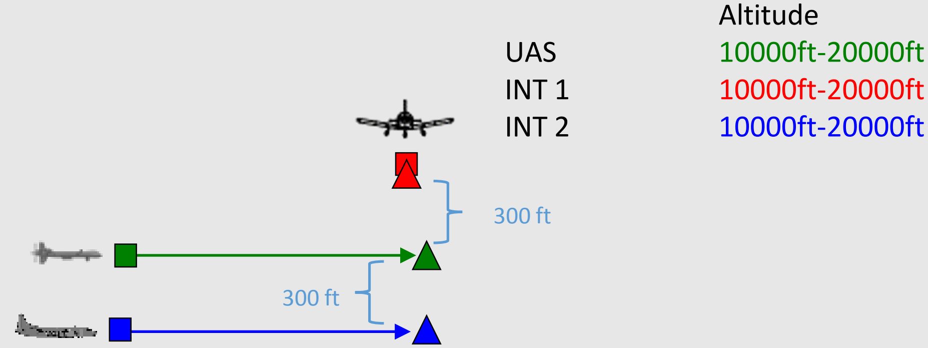
S28

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES



Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 300 ft



Scenario(s): #094

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct guidance to the UAS - provides solution away from primary and secondary intruders
2. SAA fusion processor correctly correlates tracks

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the head-on intruder aircraft. DAIDALUS Display provides the following:

- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track
- DAIDALUS does not guide the operator into a secondary encounter

Test Method

- MANEUVER –*Follow ALT/VS/Heading bands*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec
- Speed: 150-180kgs
- Vertical Speed: 500-1000fpm

Success Criteria

- Alerting progress from each alerting level
- Data collected at the LVC (Time Synced)

Expected Results

Ownship alerting

- Progress through each alerting condition
- Ownship maneuvers away from encounter prior to TCAS-RA and then maneuvers back to course

  Show images of expected alerting

Additional Information

Follow heading bands to avoid intruder
The closest point of approach (CPA) is 0.5NM

TEST OBJECTIVES

Demonstrate that DAIDALUS will not guide UAS horizontally into path of another known intruder.

Section A.5.1 DAA MOPS / Version: July 28, 2015

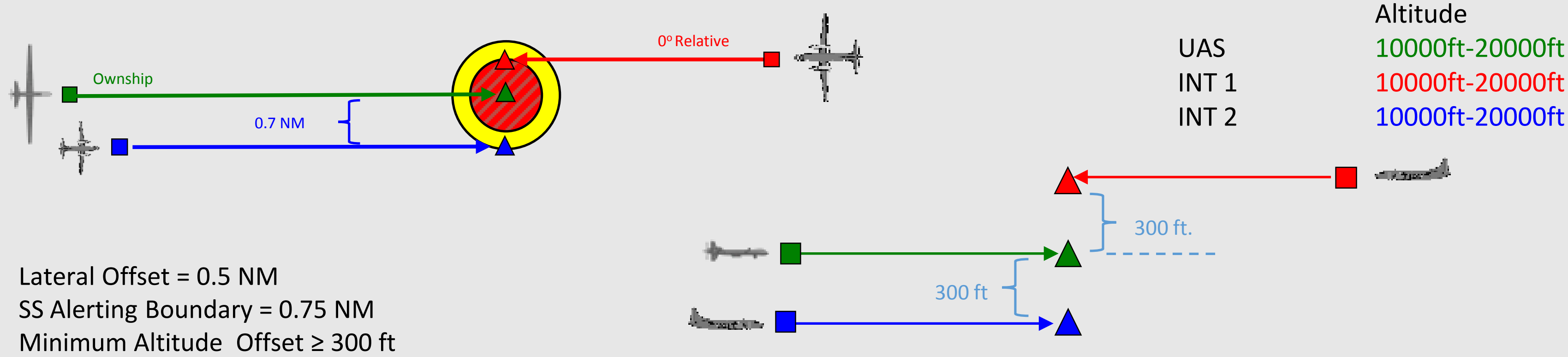
S29

Configuration

System Under Test: DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	NO	YES	YES



Scenario(s): #095

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct guidance to the UAS - provides solution away from primary and secondary intruders
2. SAA fusion processor correctly correlates tracks

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the head-on intruder aircraft. DAIDALUS Display provides the following:

- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track
- DAIDALUS does not guide the operator into a secondary encounter

Test Method

- MANEUVER –*Follow ALT/VS/Heading bands*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec
- Speed: 150-180kgs
- Vertical Speed: 500-1000fpm

Success Criteria

- Alerting progress from each alerting level
- Data collected at the LVC (Time Synced)

Expected Results

Ownship alerting

- Progress through each alerting condition
- Ownship maneuvers away from encounter prior to TCAS-RA and then maneuvers back to course

Show images of expected alerting

Additional Information

Follow heading bands to avoid intruder
The closest point of approach (CPA) is 0.5NM

TEST OBJECTIVES

Demonstrate that DAIDALUS will not guide UAS horizontally into path of another known intruder.

Section A.5.1 DAA MOPS / Version: July 28, 2015

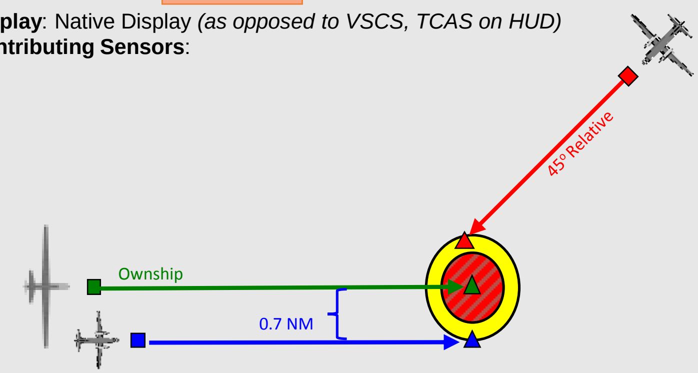
Configuration

System Under Test DAIDALUS

S30

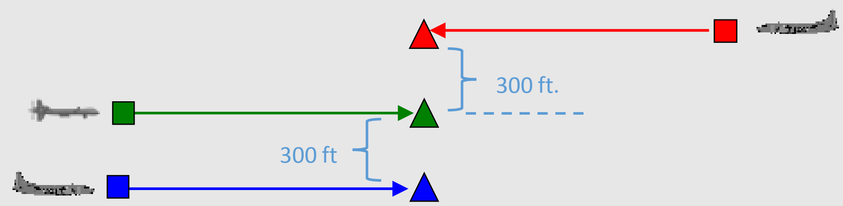
Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	NO	YES	YES



Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 400 ft

	Altitude
UAS	10000ft-20000ft
INT 1	10000ft-20000ft
INT 2	10000ft-20000ft



Scenario(s): #096

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct guidance to the UAS - provides solution away from primary and secondary intruders
2. SAA fusion processor correctly correlates tracks

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the head-on intruder aircraft. DAIDALUS Display provides the following:
- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track
- DAIDALUS does not guide the operator into a secondary encounter

Test Method

- MANEUVER –*Follow ALT/VS/Heading bands*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec
- Speed: 150-180kgs
- Vertical Speed: 500-1000fpm

Success Criteria

- Alerting progress from each alerting level
- Data collected at the LVC (Time Synced)

Expected Results

Ownship alerting
- Progress through each alerting condition
- Ownship maneuvers away from encounter prior to TCAS-RA and then maneuvers back to course

    Show images of expected alerting

Additional Information

Follow heading bands to avoid intruder
The closest point of approach (CPA) is 0.5NM

TEST OBJECTIVES

Demonstrate that DAIDALUS will not guide UAS horizontally into path of another known intruder.	Section A.5.1 DAA MOPS / Version: July 28, 2015

Configuration

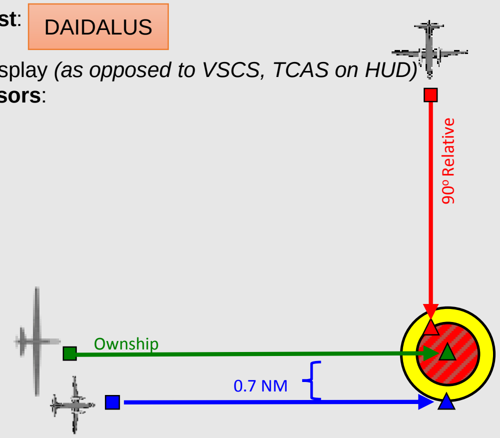
System Under Test: DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*

Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	NO	YES	YES

S31

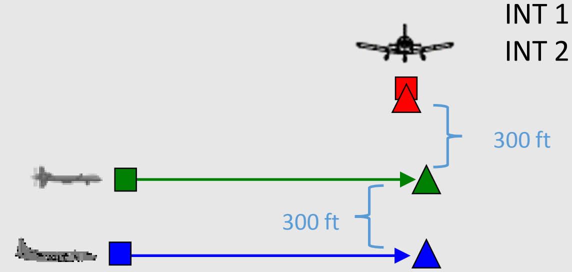


Lateral Offset = 0.5 NM

SS Alerting Boundary = 0.75 NM

Minimum Altitude Offset ≥ 400 ft

	Altitude
UAS	10000ft-20000ft
INT 1	10000ft-20000ft
INT 2	10000ft-20000ft



Scenario(s): #097

Test Objective (TO)	1. The DAIDALUS algorithm as displayed on the native display will show the correct guidance to the UAS - provides solution away from primary and secondary intruders 2. SAA fusion processor correctly correlates tracks
Evaluation Criteria	The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the head-on intruder aircraft. DAIDALUS Display provides the following: • TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA… • TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track • DAIDALUS does not guide the operator into a secondary encounter
Test Method	• MANEUVER –*Follow ALT/VS/Heading bands* • Encounter Length: 3 min • Stable Conditions: 2.5 min before CPA • Tolerance: ± 10 sec • Speed: 150-180kgs • Vertical Speed: 500-1000fpm
Success Criteria	• Alerting progress from each alerting level • Data collected at the LVC (Time Synced)
Expected Results	Ownship alerting • Progress through each alerting condition • Ownship maneuvers away from encounter prior to TCAS-RA and then maneuvers back to course *Show images of expected alerting*
Additional Information	Follow heading bands to avoid intruder The closest point of approach (CPA) is 0.5NM

Vertical Blocking

TEST OBJECTIVES

Demonstrate DAIDALUS will not guide UAS vertically into path of another known intruder.

Section A.5.1 DAA MOPS / Version: July 28, 2015

S33

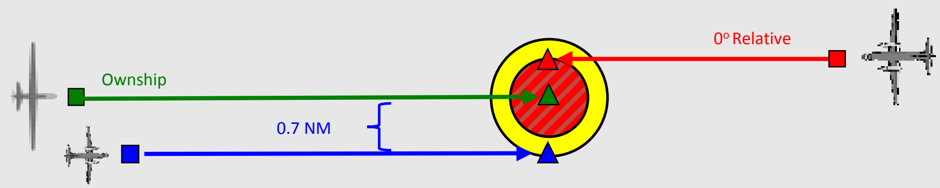
Configuration

System Under Test: DAIDALUS

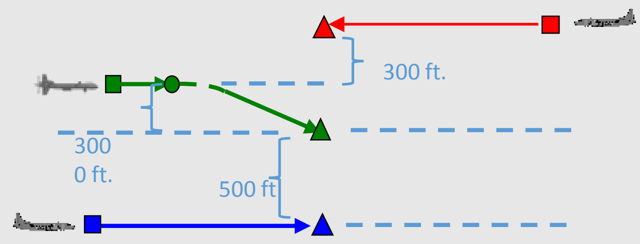
Display: Native Display *(as opposed to VSCS, TCAS on HUD)*

Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES



	Altitude
UAS	10000ft-20000ft
INT 1	10000ft-20000ft
INT 2	10000ft-20000ft



Lateral Offset = 0.5 NM

SS Alerting Boundary = 0.75 NM

Minimum Altitude Offset ≥ 300 ft

Scenario(s): #099

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting and guidance to the UAS operator.
2. SAA fusion processor correctly correlates tracks
3. Fly an encounter which causes DAIDALUS to indicate a vertical maneuver to stay well clear
4. Fly an encounter which blocks a descent maneuver

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:

- TO-1 Alerting shall progress from NO FACTOR, Proximate, preventive, corrective alerts
- DAIDALUS does not guide the operator into a secondary encounter/loss of well clear

Test Method

- MANEUVER –*Follow ALT/VS*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Descent Rate: 1000fpm
- Tolerance: ± 10 sec

Success Criteria

- Data collected from MACS display (see data requirements)
- Encounter causes DAIDALUS to provide preventive/corrective guidance
- UAS operator follows DAIDAULUS guidance

Expected Results

Ownship alerting

- Progress from no factor to corrective guidance
- Guidance will indicate a vertical solution to remain well clear.

Additional Information

Follow Alt or VS bands to avoid intruder.
The closest point of approach (CPA) for intruder 1 is 0.5NM
Intruder 2 should be on parallel path at a range of .7nm-1nm at same speed 3500ft below ownship

TEST OBJECTIVES

Demonstrate DAIDALUS will not guide UAS vertically into path of another known intruder. | **Section A.5.1 DAA MOPS / Version: July 28, 2015**

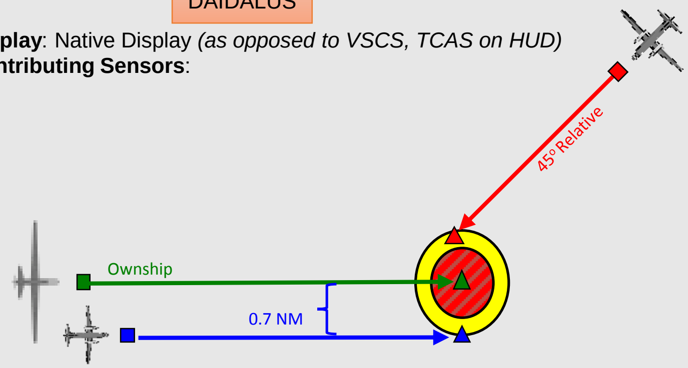
Configuration

System Under Test: DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

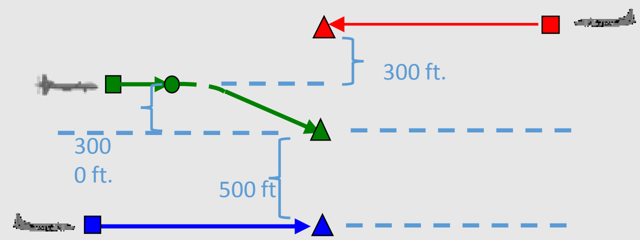
TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES

S34



Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 400 ft

	Altitude
UAS	10000ft-20000ft
INT 1	10000ft-20000ft
INT 2	10000ft-20000ft



Scenario(s): #100

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting and guidance to the UAS operator.
2. SAA fusion processor correctly correlates tracks
3. Fly an encounter which causes DAIDALUS to indicate a vertical maneuver to stay well clear
4. Fly an encounter which blocks a descent maneuver

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:

- TO-1 Alerting shall progress from NO FACTOR, Proximate, preventive, corrective alerts
- DAIDALUS does not guide the operator into a secondary encounter/loss of well clear

Test Method

- MANEUVER –*Follow ALT/VS*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Descent Rate: 1000fpm
- Tolerance: ± 10 sec

Success Criteria

- Data collected from MACS display (see data requirements)
- Encounter causes DAIDALUS to provide preventive/corrective guidance
- UAS operator follows DAIDAULUS guidance

Expected Results

Ownship alerting

- Progress from no factor to corrective guidance
- Guidance will indicate a vertical solution to remain well clear.

Additional Information

Follow Alt or VS bands to avoid intruder.
The closest point of approach (CPA) for intruder 1 is 0.5NM
Intruder 2 should be on parallel path at a range of .7nm-1nm at same speed 3500ft below ownship

TEST OBJECTIVES

Demonstrate DAIDALUS will not guide UAS vertically into path of another known intruder.	Section A.5.1 DAA MOPS / Version: July 28, 2015

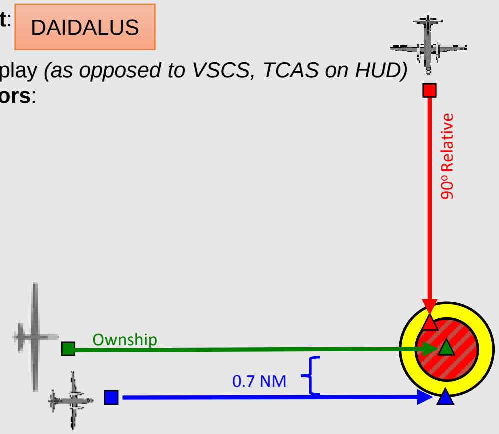
Configuration

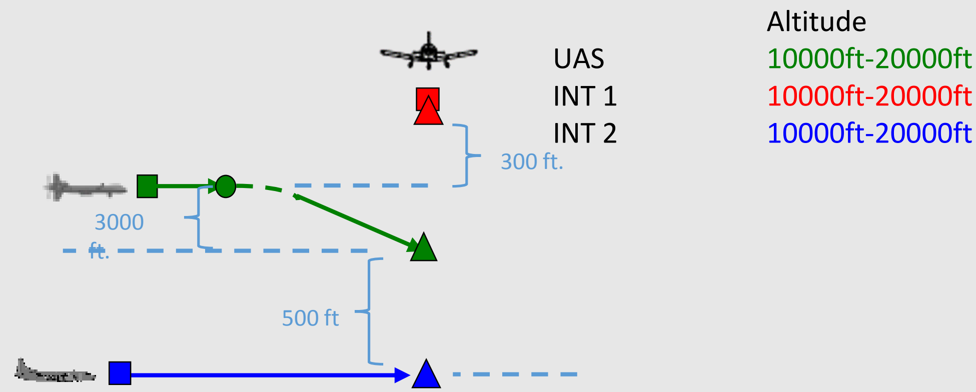
System Under Test: DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES

S35





Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 400 ft

Scenario(s): #101

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting and guidance to the UAS operator.
2. SAA fusion processor correctly correlates tracks
3. Fly an encounter which causes DAIDALUS to indicate a vertical maneuver to stay well clear
4. Fly an encounter which blocks a descent maneuver

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:
- TO-1 Alerting shall progress from NO FACTOR, Proximate, preventive, corrective alerts
- DAIDALUS does not guide the operator into a secondary encounter/loss of well clear

Test Method

- MANEUVER –*Follow ALT/VS*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Descent Rate: 1000fpm
- Tolerance: ± 10 sec

Success Criteria

- Data collected from MACS display (see data requirements)
- Encounter causes DAIDALUS to provide preventive/corrective guidance
- UAS operator follows DAIDAULUS guidance

Expected Results

Ownship alerting
- Progress from no factor to corrective guidance
- Guidance will indicate a vertical solution to remain well clear.

Additional Information

Follow Alt or VS bands to avoid intruder.
The closest point of approach (CPA) for intruder 1 is 0.5NM
Intruder 2 should be on parallel path at a range of .7nm-1nm at same speed 3500ft below ownship

TEST OBJECTIVES

Demonstrate DAIDALUS will not guide UAS vertically into path of another known intruder. | **Section A.5.1 DAA MOPS / Version: July 28, 2015**

Configuration

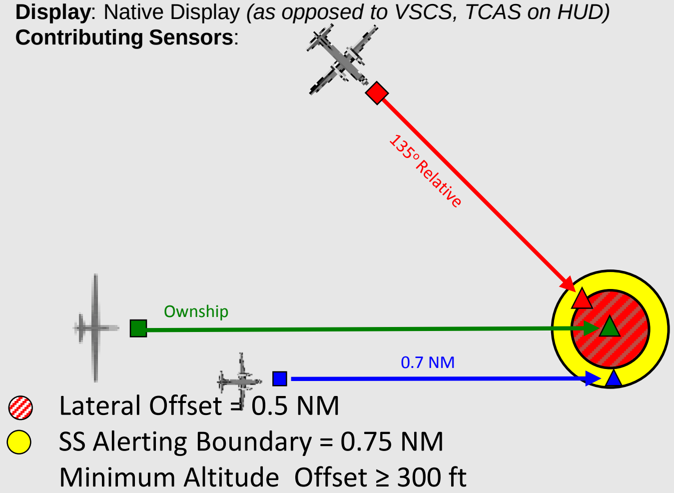
System Under Test: DAIDALUS

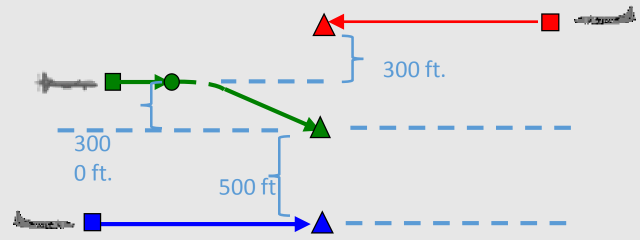
S36

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES

	Altitude
UAS	10000ft-20000ft
INT 1	10000ft-20000ft
INT 2	10000ft-20000ft





Scenario(s):
#102

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting and guidance to the UAS operator.
2. SAA fusion processor correctly correlates tracks
3. Fly an encounter which causes DAIDALUS to indicate a vertical maneuver to stay well clear
4. Fly an encounter which blocks a descent maneuver

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:

- TO-1 Alerting shall progress from NO FACTOR, Proximate, preventive, corrective alerts
- DAIDALUS does not guide the operator into a secondary encounter/loss of well clear

Test Method

- MANEUVER –*Follow ALT/VS*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Descent Rate: 1000fpm
- Tolerance: ± 10 sec

Success Criteria

- Data collected from MACS display (see data requirements)
- Encounter causes DAIDALUS to provide preventive/corrective guidance
- UAS operator follows DAIDAULUS guidance

Expected Results

Ownship alerting

- Progress from no factor to corrective guidance
- Guidance will indicate a vertical solution to remain well clear.

Additional Information

Follow Alt or VS bands to avoid intruder.
The closest point of approach (CPA) for intruder 1 is 0.5NM
Intruder 2 should be on parallel path at a range of .7nm-1nm at same speed 3500ft below ownship

TEST OBJECTIVES

Demonstrate DAIDALUS will not guide UAS vertically into path of another known intruder.

Section A.5.1 DAA MOPS / Version: July 28, 2015

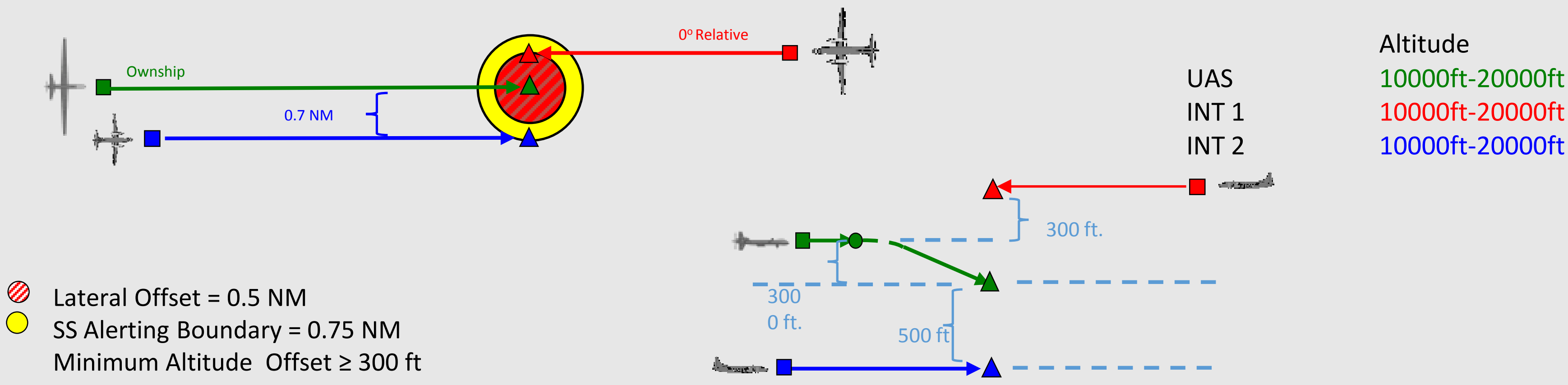
Configuration

System Under Test: DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	NO	YES	YES

S37



Scenario(s): #103

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting and guidance to the UAS operator.
2. SAA fusion processor correctly correlates tracks
3. Fly an encounter which causes DAIDALUS to indicate a vertical maneuver to stay well clear
4. Fly an encounter which blocks a descent maneuver

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:

- TO-1 Alerting shall progress from NO FACTOR, Proximate, preventive, corrective alerts
- DAIDALUS does not guide the operator into a secondary encounter/loss of well clear
-

Test Method

- MANEUVER –*Follow ALT/VS*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Descent Rate: 1000fpm
- Tolerance: ± 10 sec

Success Criteria

- Data collected from MACS display (see data requirements)
- Encounter causes DAIDALUS to provide preventive/corrective guidance
- UAS operator follows DAIDAULUS guidance

Expected Results

Ownship alerting

- Progress from no factor to corrective guidance
- Guidance will indicate a vertical solution to remain well clear.

Additional Information

Follow Alt or VS bands to avoid intruder.
The closest point of approach (CPA) for intruder 1 is 0.5NM
Intruder 2 should be on parallel path at a range of .7nm-1nm at same speed 3500ft below ownship

TEST OBJECTIVES

Demonstrate DAIDALUS will not guide UAS vertically into path of another known intruder.

Section A.5.1 DAA MOPS / Version: July 28, 2015

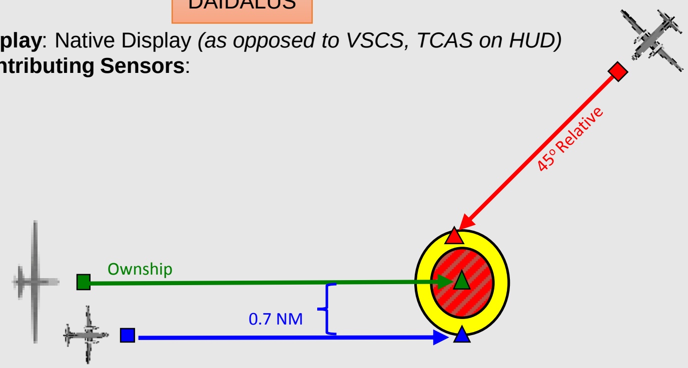
Configuration

System Under Test: DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

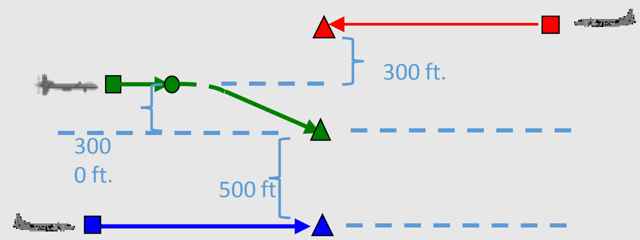
TCAS	ADS-B	Radar	Fusion
YES	NO	YES	YES

S34



Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 400 ft

	Altitude
UAS	10000ft-20000ft
INT 1	10000ft-20000ft
INT 2	10000ft-20000ft



Scenario(s): #104

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting and guidance to the UAS operator.
2. SAA fusion processor correctly correlates tracks
3. Fly an encounter which causes DAIDALUS to indicate a vertical maneuver to stay well clear
4. Fly an encounter which blocks a descent maneuver

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:

- TO-1 Alerting shall progress from NO FACTOR, Proximate, preventive, corrective alerts
- DAIDALUS does not guide the operator into a secondary encounter/loss of well clear

Test Method

- MANEUVER –*Follow ALT/VS*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Descent Rate: 1000fpm
- Tolerance: ± 10 sec

Success Criteria

- Data collected from MACS display (see data requirements)
- Encounter causes DAIDALUS to provide preventive/corrective guidance
- UAS operator follows DAIDAULUS guidance

Expected Results

Ownship alerting

- Progress from no factor to corrective guidance
- Guidance will indicate a vertical solution to remain well clear.

Additional Information

Follow Alt or VS bands to avoid intruder.
The closest point of approach (CPA) for intruder 1 is 0.5NM
Intruder 2 should be on parallel path at a range of .7nm-1nm at same speed 3500ft below ownship

TEST OBJECTIVES

Demonstrate DAIDALUS will not guide UAS vertically into path of another known intruder.

Section A.5.1 DAA MOPS / Version: July 28, 2015

Configuration

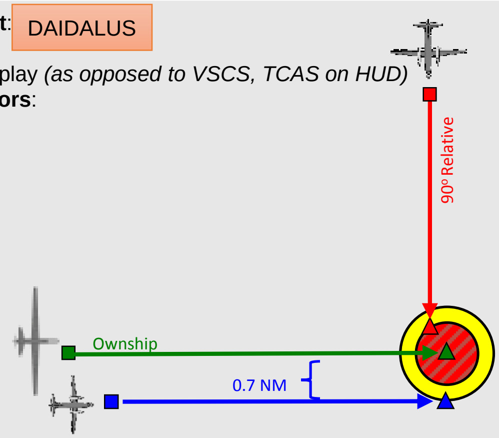
S39

System Under Test: DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*

Contributing Sensors:

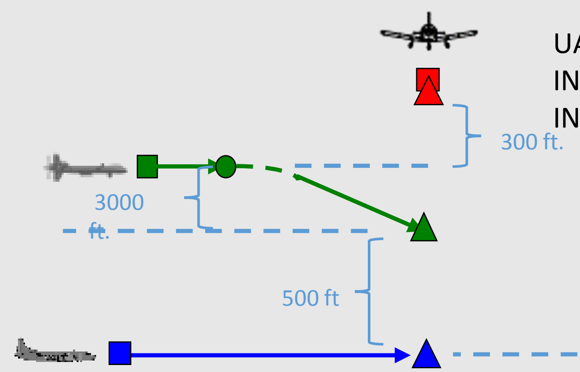
TCAS	ADS-B	Radar	Fusion
YES	NO	YES	YES



Lateral Offset = 0.5 NM

SS Alerting Boundary = 0.75 NM

Minimum Altitude Offset ≥ 400 ft



	Altitude
UAS	10000ft-20000ft
INT 1	10000ft-20000ft
INT 2	10000ft-20000ft

Scenario(s): #105

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting and guidance to the UAS operator.
2. SAA fusion processor correctly correlates tracks
3. Fly an encounter which causes DAIDALUS to indicate a vertical maneuver to stay well clear
4. Fly an encounter which blocks a descent maneuver

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:

- TO-1 Alerting shall progress from NO FACTOR, Proximate, preventive, corrective alerts
- DAIDALUS does not guide the operator into a secondary encounter/loss of well clear

Test Method

- MANEUVER –*Follow ALT/VS*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Descent Rate: 1000fpm
- Tolerance: ± 10 sec

Success Criteria

- Data collected from MACS display (see data requirements)
- Encounter causes DAIDALUS to provide preventive/corrective guidance
- UAS operator follows DAIDAULUS guidance

Expected Results

Ownship alerting

- Progress from no factor to corrective guidance
- Guidance will indicate a vertical solution to remain well clear.

Additional Information

Follow Alt or VS bands to avoid intruder.
The closest point of approach (CPA) for intruder 1 is 0.5NM
Intruder 2 should be on parallel path at a range of .7nm-1nm at same speed 3500ft below ownship

High/Low Altitude Maneuvering

TEST OBJECTIVES

Demonstrate DAIDALUS will not guide UAS vertically into path of another known intruder.	**Section A.5.1 DAA MOPS / Version: July 28, 2015**

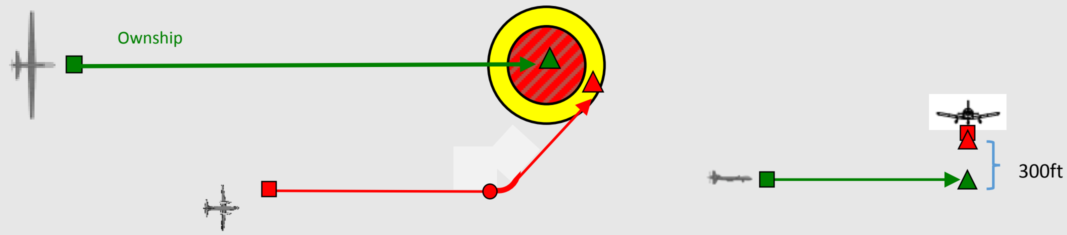
S41

Configuration

System Under Test DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES



	Altitude
UAS	5000ft-10000ft
INT 1	5000ft-10000ft

Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 300 ft

Scenario(s): #107

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting to the UAS in a rear-quartering scenario
2. SAA fusion processor correctly correlates tracks
3. Demonstrate TCAS RA boundary in relation to well clear boundary at TCAS SL5

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:
- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track

Test Method

- MANEUVER –*Follow heading/alt/VS bands to stay well clear once TCAS RA is displayed*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec

Success Criteria

- Data collected from MACS display (see data requirements)
- Achieve TCAS RA

Expected Results

Ownship alerting
- Progress through each alerting condition
- Receive RA before the well clear boundary

Additional Information

Follow Heading, Alt or VS bands to avoid intruder.
The closest point of approach (CPA) is 0.5NM

TEST OBJECTIVES

Demonstrate DAIDALUS will not guide UAS vertically into path of another known intruder.	Section A.5.1 DAA MOPS / Version: July 28, 2015

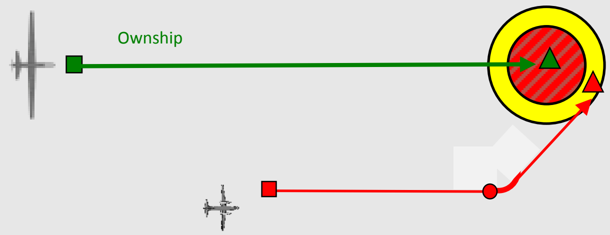
S42

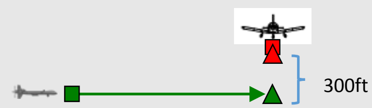
Configuration

System Under Test: DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES





	Altitude
UAS	10000ft-20000ft
INT 1	10000ft-20000ft

Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 300 ft

Scenario(s): #108

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting to the UAS in a rear-quartering scenario
2. SAA fusion processor correctly correlates tracks
3. Demonstrate TCAS RA boundary in relation to well clear boundary at TCAS SL6

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:
- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track

Test Method

- MANEUVER –*Follow heading/alt/VS bands to stay well clear once TCAS RA is displayed*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec

Success Criteria

- Data collected from MACS display (see data requirements)
- Achieve TCAS RA

Expected Results

Ownship alerting
- Progress through each alerting condition
- Receive RA before the well clear boundary

Additional Information

Follow Alt or VS bands to avoid intruder.
The closest point of approach (CPA) is 0.5NM

TEST OBJECTIVES

Demonstrate DAIDALUS will not guide UAS vertically into path of another known intruder.

Section A.5.1 DAA MOPS / Version: July 28, 2015

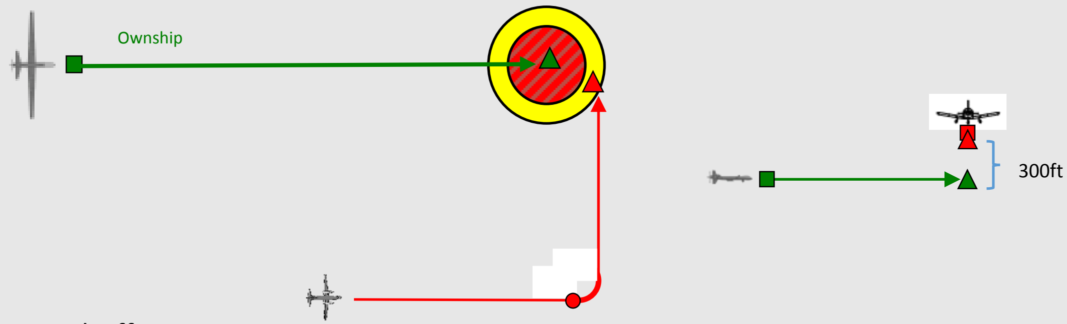
S43

Configuration

System Under Test DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES



	Altitude
UAS	5000ft-10000ft
INT 1	5000ft-10000ft

Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 300 ft

Scenario(s): #109

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting to the UAS in a rear-quartering scenario
2. SAA fusion processor correctly correlates tracks
3. Demonstrate TCAS RA boundary in relation to well clear boundary at TCAS SL5

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:

- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track

Test Method

- MANEUVER –*Follow heading/alt/VS bands to stay well clear once TCAS RA is displayed*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec

Success Criteria

- Data collected from MACS display (see data requirements)
- Achieve TCAS RA

Expected Results

Ownship alerting

- Progress through each alerting condition
- Receive RA before the well clear boundary

Additional Information

Follow Alt or VS bands to avoid intruder.
The closest point of approach (CPA) is 0.5NM

TEST OBJECTIVES

Demonstrate DAIDALUS will not guide UAS vertically into path of another known intruder.	Section A.5.1 DAA MOPS / Version: July 28, 2015

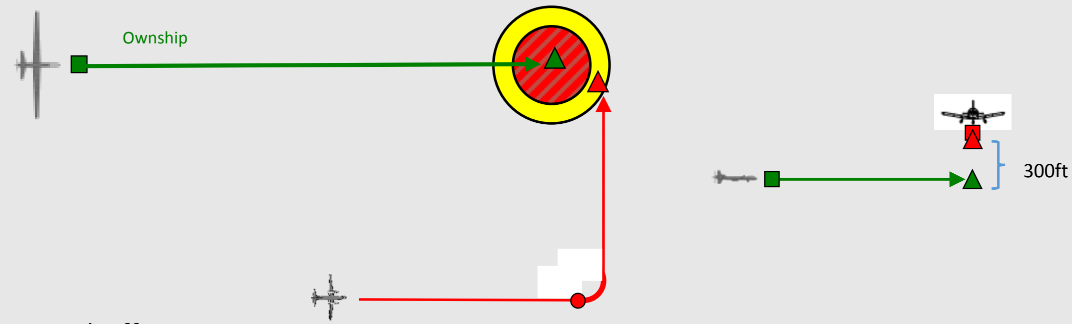
Configuration

System Under Test: DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES

S43



	Altitude
UAS	10000ft-20000ft
INT 1	10000ft-20000ft

Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 300 ft

Scenario(s): #110

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting to the UAS in a rear-quartering scenario
2. SAA fusion processor correctly correlates tracks
3. Demonstrate TCAS RA boundary in relation to well clear boundary at TCAS SL6

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:
- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track

Test Method

- MANEUVER –*Follow heading/alt/VS bands to stay well clear once TCAS RA is displayed*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec

Success Criteria

- Data collected from MACS display (see data requirements)
- Achieve TCAS RA

Expected Results

Ownship alerting
- Progress through each alerting condition
- Receive RA before the well clear boundary

Additional Information

Follow Alt or VS bands to avoid intruder.
The closest point of approach (CPA) is 0.5NM

TEST OBJECTIVES

Demonstrate DAIDALUS will not guide UAS vertically into path of another known intruder.

Section A.5.1 DAA MOPS / Version: July 28, 2015

Configuration

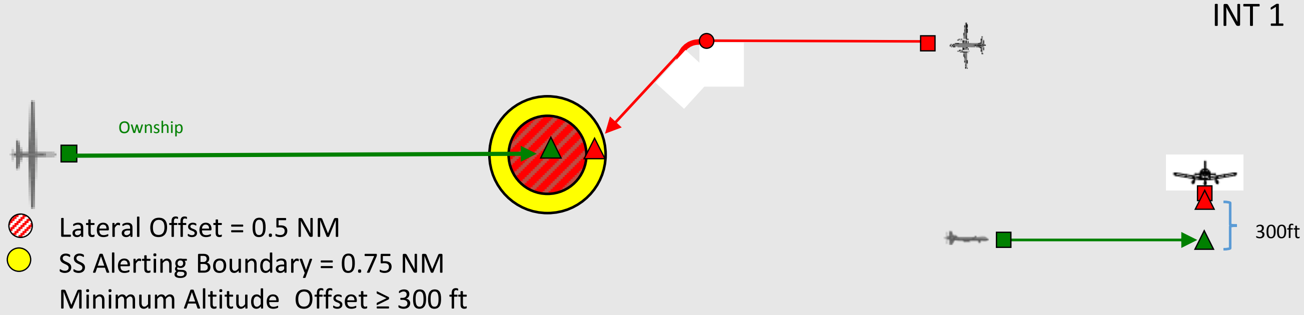
System Under Test: DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES

S43

	Altitude
UAS	5000ft-10000ft
INT 1	5000ft-10000ft



Scenario(s): #111

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting to the UAS in a rear-quartering scenario
2. SAA fusion processor correctly correlates tracks
3. Demonstrate TCAS RA boundary in relation to well clear boundary at SL5

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:

- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track

Test Method

- MANEUVER –*Follow heading/alt/VS bands to stay well clear once TCAS RA is displayed*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec

Success Criteria

- Data collected from MACS display (see data requirements)
- Achieve TCAS RA

Expected Results

Ownship alerting

- Progress through each alerting condition
- Receive RA before the well clear boundary

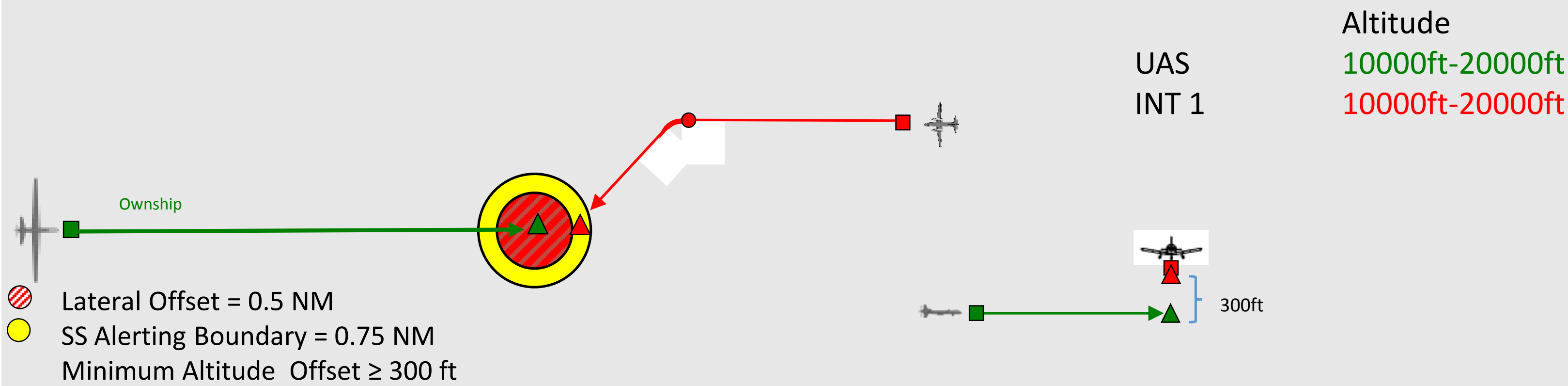
Additional Information

Follow Alt or VS bands to avoid intruder.
The closest point of approach (CPA) is 0.5NM

TEST OBJECTIVES

Demonstrate DAIDALUS will not guide UAS vertically into path of another known intruder.	Section A.5.1 DAA MOPS / Version: July 28, 2015

S43

Configuration **Scenario(s): #112**	**System Under Test** DAIDALUS **Display**: Native Display *(as opposed to VSCS, TCAS on HUD)* **Contributing Sensors**: <table><tr><th>TCAS</th><th>ADS-B</th><th>Radar</th><th>Fusion</th></tr><tr><td>YES</td><td>YES</td><td>YES</td><td>YES</td></tr></table> 
Test Objective (TO)	1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting to the UAS in a rear-quartering scenario 2. SAA fusion processor correctly correlates tracks 3. Demonstrate TCAS RA boundary in relation to well clear boundary at SL6
Evaluation Criteria	The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following: • TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA… • TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track
Test Method	• MANEUVER –*Follow heading/alt/VS bands to stay well clear once TCAS RA is displayed* • Encounter Length: 3 min • Stable Conditions: 2.5 min before CPA • Tolerance: ± 10 sec
Success Criteria	• Data collected from MACS display (see data requirements) • Achieve TCAS RA
Expected Results	Ownship alerting • Progress through each alerting condition • Receive RA before the well clear boundary
Additional Information	Follow Alt or VS bands to avoid intruder. The closest point of approach (CPA) is 0.5NM

TEST OBJECTIVES

Demonstrate DAIDALUS will not guide UAS vertically into path of another known intruder.	**Section A.5.1 DAA MOPS / Version: July 28, 2015**

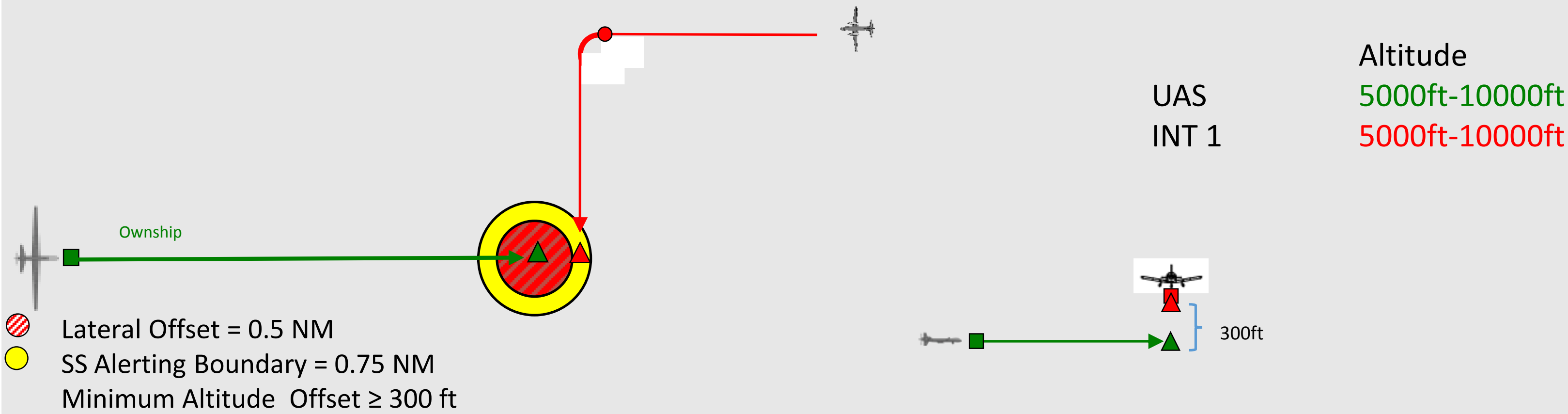
S43

Configuration

System Under Test: DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES



Scenario(s): #113

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting to the UAS in a rear-quartering scenario
2. SAA fusion processor correctly correlates tracks
3. Demonstrate TCAS RA boundary in relation to well clear boundary SL5

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:
- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track

Test Method

- MANEUVER –*Follow heading/alt/VS bands to stay well clear once TCAS RA is displayed*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec

Success Criteria

- Data collected from MACS display (see data requirements)
- Achieve TCAS RA

Expected Results

Ownship alerting
- Progress through each alerting condition
- Receive RA before the well clear boundary

Additional Information

Follow Alt or VS bands to avoid intruder.
The closest point of approach (CPA) is 0.5NM

TEST OBJECTIVES

Demonstrate DAIDALUS will not guide UAS vertically into path of another known intruder.	**Section A.5.1 DAA MOPS / Version: July 28, 2015**

Configuration

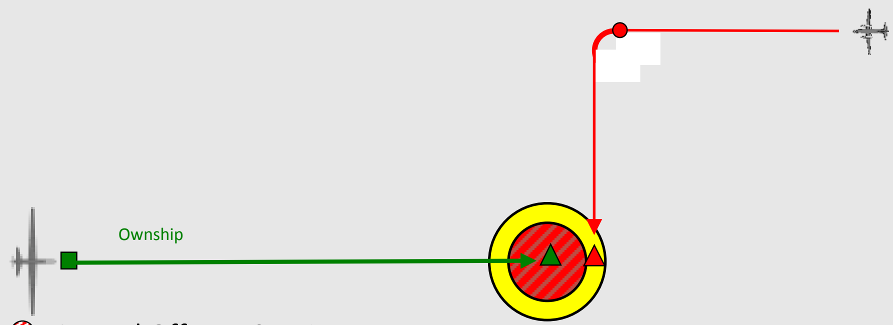
System Under Test: DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

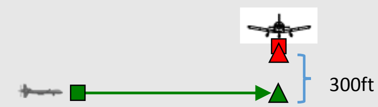
TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES

S43

	Altitude
UAS	10000ft-20000ft
INT 1	10000ft-20000ft



Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 300 ft



Scenario(s): #114

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting to the UAS in a rear-quartering scenario
2. SAA fusion processor correctly correlates tracks
3. Demonstrate TCAS RA boundary in relation to well clear boundary SL6

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:
- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track

Test Method

- MANEUVER –*Follow heading/alt/VS bands to stay well clear once TCAS RA is displayed*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec

Success Criteria

- Data collected from MACS display (see data requirements)
- Achieve TCAS RA

Expected Results

Ownship alerting
- Progress through each alerting condition
- Receive RA before the well clear boundary

Additional Information

Follow Alt or VS bands to avoid intruder.
The closest point of approach (CPA) is 0.5NM

High Speed Maneuvering

TEST OBJECTIVES

Demonstrate DAIDALUS will not guide UAS vertically into path of another known intruder.

Section A.5.1 DAA MOPS / Version: July 28, 2015

Configuration

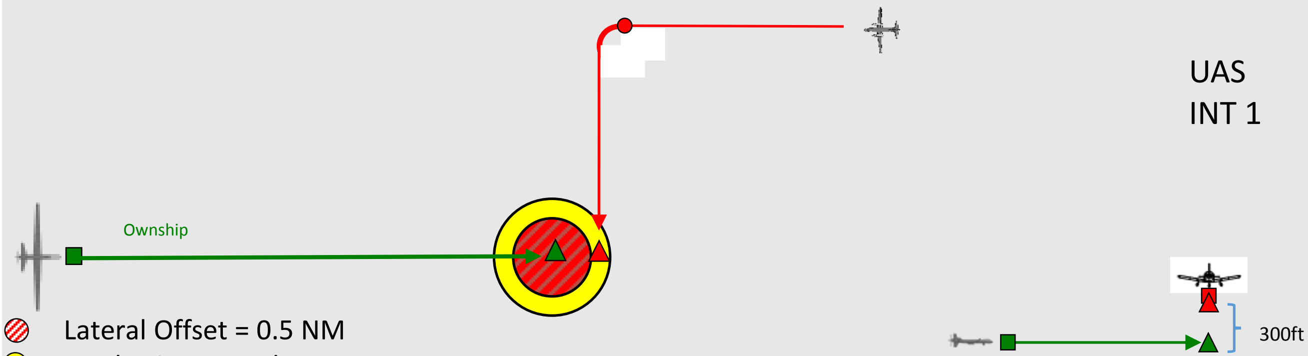
S43

System Under Test: DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES

	Altitude
UAS	10000ft-20000ft
INT 1	10000ft-20000ft



Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 300 ft

Scenario(s): #115

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting to the UAS in a rear-quartering scenario
2. SAA fusion processor correctly correlates tracks
3. Demonstrate DAIDALUS performance with maneuvering high speed intruder

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:
- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track

Test Method

- MANEUVER –*Follow heading, alt or VS bands to remain well clear*
- *Speed: 400KGS*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Climb Rate:
- Roll Rate:
- Pitch Rate:
- Tolerance: ± 10 sec

Success Criteria

- Data collected from MACS display (see data requirements

Expected Results

Ownship alerting
- Progress through each alerting condition

Additional Information

Follow Heading, Alt or VS bands to avoid intruder.
The closest point of approach (CPA) is 0.5NM

TEST OBJECTIVES

Demonstrate DAIDALUS will not guide UAS vertically into path of another known intruder.	Section A.5.1 DAA MOPS / Version: July 28, 2015

S43

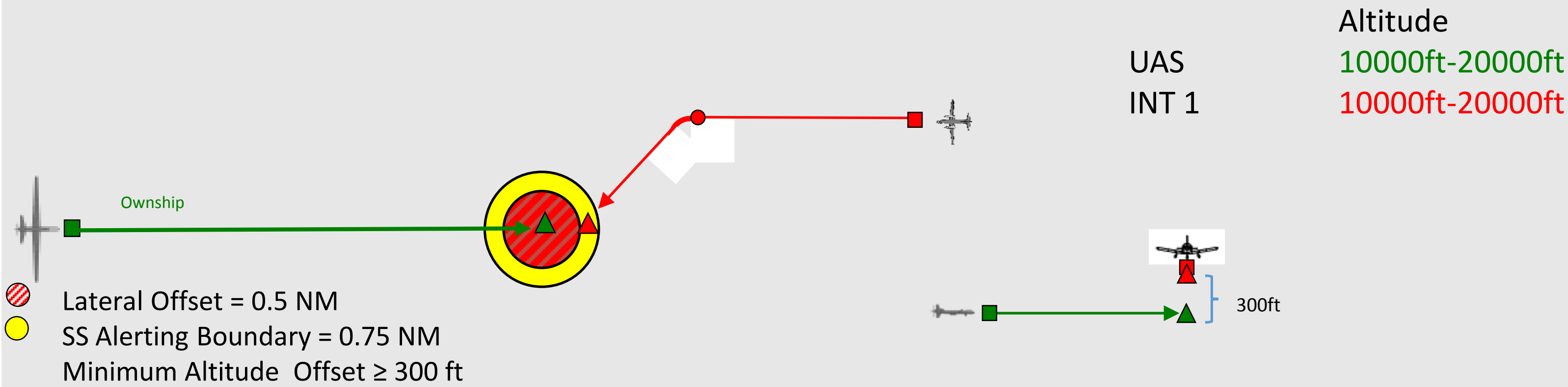
Configuration

System Under Test: DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES

Scenario(s): #116



Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting to the UAS in a rear-quartering scenario
2. SAA fusion processor correctly correlates tracks
3. Demonstrate DAIDALUS performance with maneuvering high speed intruder

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:

- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track

Test Method

- MANEUVER –*Follow heading/alt/VS bands to stay well clear*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Climb Rate:
- Roll Rate:
- Pitch Rate:
- Tolerance: ± 10 sec

Success Criteria

- UAS Maneuvers away from intruder before TCAS-RA
- Alerting progress from each alerting level
- Data collected at the LVC (Time Synced)
    - Data type 1
    - Data type 2…

Expected Results

Ownship alerting

- Progress through each alerting condition
- Ownship maneuvers away from encounter prior to TCAS-RA and then maneuvers back to course

    Show images of expected alerting

Additional Information

Follow Alt or VS bands to avoid intruder.
The closest point of approach (CPA) is 0.5NM

TEST OBJECTIVES

Demonstrate DAIDALUS will not guide UAS vertically into path of another known intruder.

Section A.5.1 DAA MOPS / Version: July 28, 2015

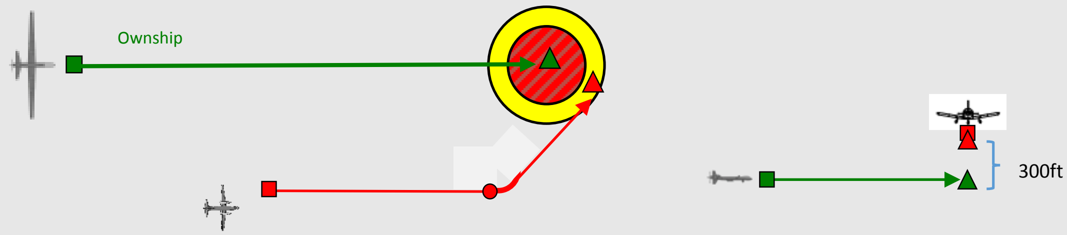
Configuration

System Under Test: DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES

S42



	Altitude
UAS	10000ft-20000ft
INT 1	10000ft-20000ft

Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 300 ft

Scenario(s): #117

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting to the UAS in a rear-quartering scenario
2. SAA fusion processor correctly correlates tracks
3. Demonstrate DAIDALUS performance with maneuvering high speed intruder

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:

- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track

Test Method

- MANEUVER –*Follow heading/alt/VS bands to stay well clear*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Climb Rate:
- Roll Rate:
- Pitch Rate:
- Tolerance: ± 10 sec

Success Criteria

- UAS Maneuvers away from intruder before TCAS-RA
- Alerting progress from each alerting level
- Data collected at the LVC (Time Synced)
    - Data type 1
    - Data type 2…

Expected Results

Ownship alerting

- Progress through each alerting condition
- Ownship maneuvers away from encounter prior to TCAS-RA and then maneuvers back to course

    Show images of expected alerting

Additional Information

Follow Alt or VS bands to avoid intruder.
The closest point of approach (CPA) is 0.5NM

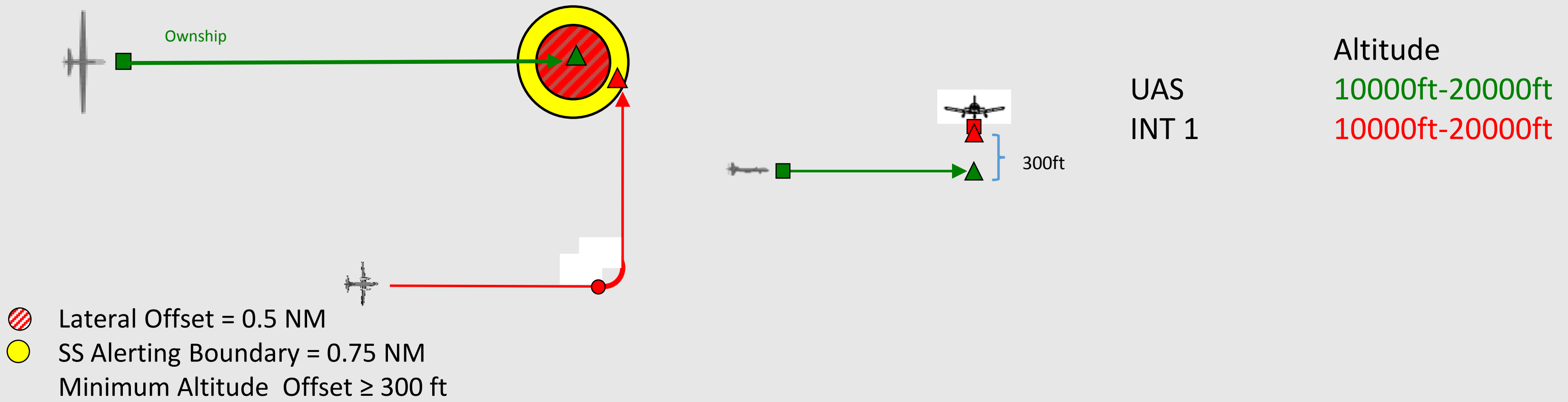
TEST OBJECTIVES

Demonstrate DAIDALUS will not guide UAS vertically into path of another known intruder.	**Section A.5.1 DAA MOPS / Version: July 28, 2015**

Configuration	**System Under Test**: DAIDALUS **Display**: Native Display *(as opposed to VSCS, TCAS on HUD)* **Contributing Sensors**:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES

S43



Scenario(s): #118

Test Objective (TO)	1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting to the UAS in a rear-quartering scenario 2. SAA fusion processor correctly correlates tracks 3. Demonstrate DAIDALUS performance with maneuvering high speed intruder
Evaluation Criteria	The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following: • TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA… • TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track
Test Method	• MANEUVER –*Follow heading/alt/VS bands to stay well clear* • Encounter Length: 3 min • Stable Conditions: 2.5 min before CPA • Climb Rate: • Roll Rate: • Pitch Rate: • Tolerance: ± 10 sec

Success Criteria	• UAS Maneuvers away from intruder before TCAS-RA
	• Alerting progress from each alerting level
	• Data collected at the LVC (Time Synced)
	    • Data type 1
	    • Data type 2…

Expected Results	Ownship alerting • Progress through each alerting condition • Ownship maneuvers away from encounter prior to TCAS-RA and then maneuvers back to course *Show images of expected alerting*
Additional Information	Follow Alt or VS bands to avoid intruder. The closest point of approach (CPA) is 0.5NM

Maneuvering/Blocking

TEST OBJECTIVES

Demonstrate DAIDALUS will not guide UAS vertically into path of another known intruder. | **Section A.5.1 DAA MOPS / Version: July 28, 2015**

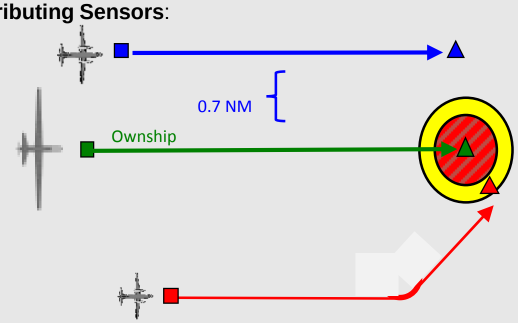
Configuration

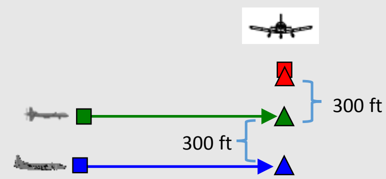
System Under Test: DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	NO	YES	YES

S38





	Altitude
UAS	10000ft-20000ft
INT 1	10000ft-20000ft
INT 2	10000ft-20000ft

Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 400 ft

Scenario(s): #123

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting and guidance to the UAS operator.
2. SAA fusion processor correctly correlates tracks
3. Fly an encounter which blocks a descent maneuver

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:

- TO-1 Alerting shall progress from NO FACTOR, Proximate, preventive, corrective alerts
- DAIDALUS does not guide the operator into a secondary encounter/loss of well clear

Test Method

- MANEUVER –*Follow HDG/ALT/VS bands to stay well clear*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec

Success Criteria

- Data collected from MACS display (see data requirements)
- Encounter causes DAIDALUS to provide preventive/corrective guidance
- UAS operator follows DAIDAULUS guidance

Expected Results

Ownship alerting

- Progress from no factor to corrective guidance
- Guidance will indicate a vertical solution to remain well clear.
- Guidance will not indicate a turn towards the secondary intruder

Additional Information

Follow Alt or VS bands to avoid intruder.
The closest point of approach (CPA) is 0.5NM for intruder 1
Intruder 2 should be on parallel path .7nm-1nm at same velocity as ownship

TEST OBJECTIVES

Demonstrate DAIDALUS will not guide UAS vertically into path of another known intruder. | **Section A.5.1 DAA MOPS / Version: July 28, 2015**

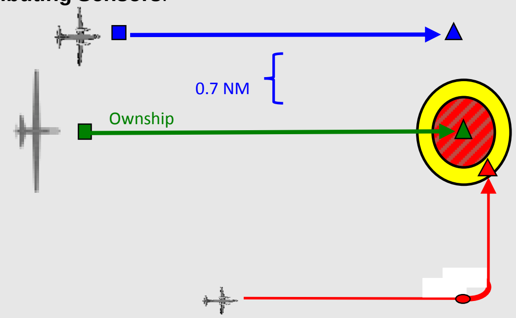
Configuration

System Under Test: DAIDALUS

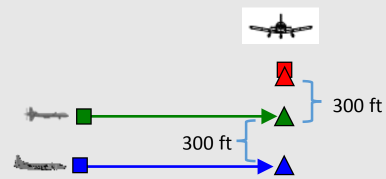
S38

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	NO	YES	YES



	Altitude
UAS	10000ft-20000ft
INT 1	10000ft-20000ft
INT 2	10000ft-20000ft



Scenario(s): #124

Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 400 ft

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting and guidance to the UAS operator.
2. SAA fusion processor correctly correlates tracks
3. Fly an encounter which blocks a descent maneuver

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:
- TO-1 Alerting shall progress from NO FACTOR, Proximate, preventive, corrective alerts
- DAIDALUS does not guide the operator into a secondary encounter/loss of well clear

Test Method

- MANEUVER –*Follow HDG/ALT/VS bands to stay well clear*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec

Success Criteria

- Data collected from MACS display (see data requirements)
- Encounter causes DAIDALUS to provide preventive/corrective guidance
- UAS operator follows DAIDAULUS guidance

Expected Results

Ownship alerting
- Progress from no factor to corrective guidance
- Guidance will indicate a vertical solution to remain well clear.
- Guidance will not indicate a turn towards the secondary intruder

Additional Information

Follow Alt or VS bands to avoid intruder.
The closest point of approach (CPA) is 0.5NM for intruder 1
Intruder 2 should be on parallel path .7nm-1nm at same velocity as ownship

TEST OBJECTIVES

Demonstrate DAIDALUS will not guide UAS vertically into path of another known intruder. | **Section A.5.1 DAA MOPS / Version: July 28, 2015**

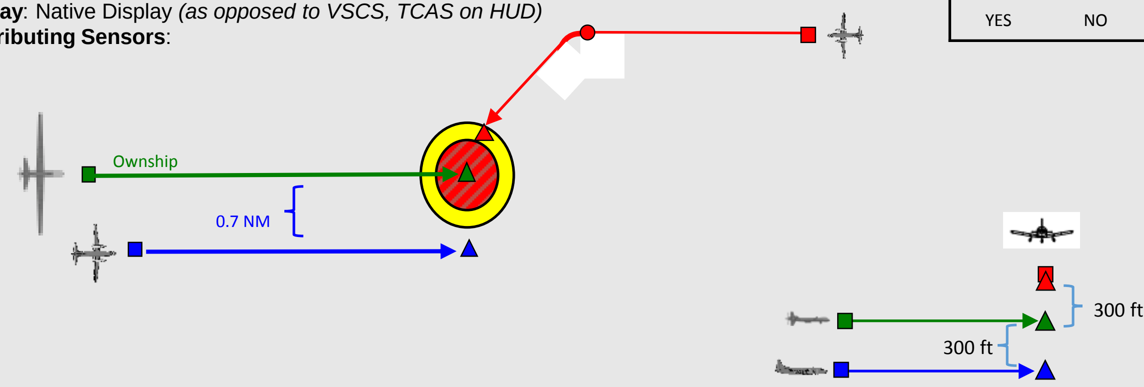
Configuration

System Under Test: DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	NO	YES	YES

S38



	Altitude
UAS	10000ft-20000ft
INT 1	10000ft-20000ft
INT 2	10000ft-20000ft

Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 400 ft

Scenario(s): #125

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting and guidance to the UAS operator.
2. SAA fusion processor correctly correlates tracks
3. Fly an encounter which blocks a descent maneuver

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:
- TO-1 Alerting shall progress from NO FACTOR, Proximate, preventive, corrective alerts
- DAIDALUS does not guide the operator into a secondary encounter/loss of well clear

Test Method

- MANEUVER –*Follow HDG/ALT/VS bands to stay well clear*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec

Success Criteria

- Data collected from MACS display (see data requirements)
- Encounter causes DAIDALUS to provide preventive/corrective guidance
- UAS operator follows DAIDAULUS guidance

Expected Results

Ownship alerting
- Progress from no factor to corrective guidance
- Guidance will indicate a vertical solution to remain well clear.
- Guidance will not indicate a turn towards the secondary intruder

Additional Information

Follow Alt or VS bands to avoid intruder.
The closest point of approach (CPA) is 0.5NM for intruder 1
Intruder 2 should be on parallel path .7nm-1nm at same velocity as ownship

TEST OBJECTIVES

Demonstrate DAIDALUS will not guide UAS vertically into path of another known intruder.	Section A.5.1 DAA MOPS / Version: July 28, 2015

Configuration

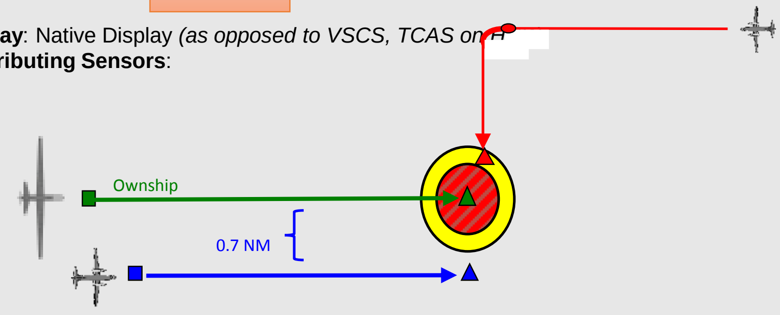
System Under Test: DAIDALUS

S38

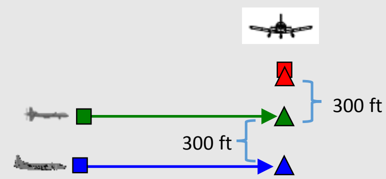
Display: Native Display *(as opposed to VSCS, TCAS on H*

Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	NO	YES	YES



	Altitude
UAS	10000ft-20000ft
INT 1	10000ft-20000ft
INT 2	10000ft-20000ft



Scenario(s): #126

Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 400 ft

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting and guidance to the UAS operator.
2. SAA fusion processor correctly correlates tracks
3. Fly an encounter which blocks a descent maneuver

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:
- TO-1 Alerting shall progress from NO FACTOR, Proximate, preventive, corrective alerts
- DAIDALUS does not guide the operator into a secondary encounter/loss of well clear

Test Method

- MANEUVER –*Follow HDG/ALT/VS bands to stay well clear*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec

Success Criteria

- Data collected from MACS display (see data requirements)
- Encounter causes DAIDALUS to provide preventive/corrective guidance
- UAS operator follows DAIDAULUS guidance

Expected Results

Ownship alerting
- Progress from no factor to corrective guidance
- Guidance will indicate a vertical solution to remain well clear.
- Guidance will not indicate a turn towards the secondary intruder

Additional Information

Follow Alt or VS bands to avoid intruder.
The closest point of approach (CPA) is 0.5NM for intruder 1
Intruder 2 should be on parallel path .7nm-1nm at same velocity as ownship

TEST OBJECTIVES

Demonstrate DAIDALUS will not guide UAS vertically into path of another known intruder.	Section A.5.1 DAA MOPS / Version: July 28, 2015

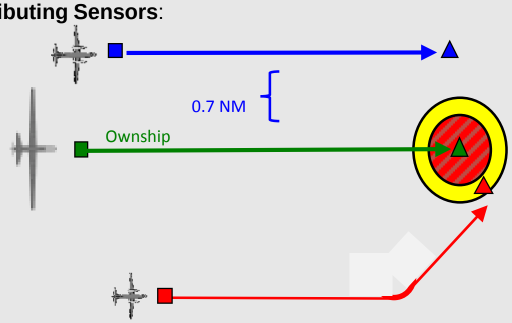
S38

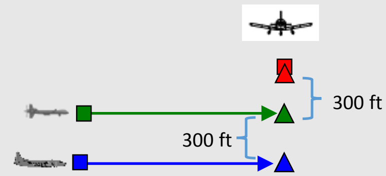
Configuration

System Under Test: DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES





	Altitude
UAS	10000ft-20000ft
INT 1	10000ft-20000ft
INT 2	10000ft-20000ft

Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 400 ft

Scenario(s): #127

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting and guidance to the UAS operator.
2. SAA fusion processor correctly correlates tracks
3. Fly an encounter which blocks a descent maneuver

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:

- TO-1 Alerting shall progress from NO FACTOR, Proximate, preventive, corrective alerts
- DAIDALUS does not guide the operator into a secondary encounter/loss of well clear

Test Method

- MANEUVER –*Follow HDG/ALT/VS bands to stay well clear*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec

Success Criteria

- Data collected from MACS display (see data requirements)
- Encounter causes DAIDALUS to provide preventive/corrective guidance
- UAS operator follows DAIDAULUS guidance

Expected Results

Ownship alerting

- Progress from no factor to corrective guidance
- Guidance will indicate a vertical solution to remain well clear.
- Guidance will not indicate a turn towards the secondary intruder

Additional Information

Follow Alt or VS bands to avoid intruder.
The closest point of approach (CPA) is 0.5NM for intruder 1
Intruder 2 should be on parallel path .7nm-1nm at same velocity as ownship

TEST OBJECTIVES

Demonstrate DAIDALUS will not guide UAS vertically into path of another known intruder. | **Section A.5.1 DAA MOPS / Version: July 28, 2015**

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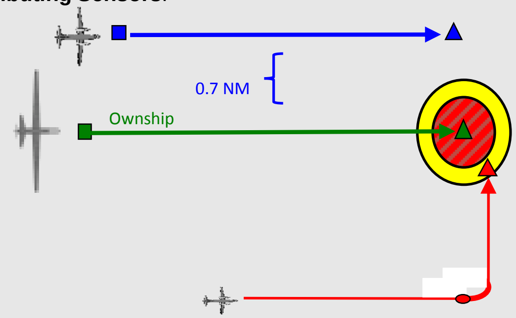
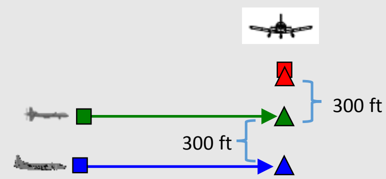
Configuration

System Under Test: DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES





	Altitude
UAS	10000ft-20000ft
INT 1	10000ft-20000ft
INT 2	10000ft-20000ft

Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 400 ft

Scenario(s): #128

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting and guidance to the UAS operator.
2. SAA fusion processor correctly correlates tracks
3. Fly an encounter which blocks a descent maneuver

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:

- TO-1 Alerting shall progress from NO FACTOR, Proximate, preventive, corrective alerts
- DAIDALUS does not guide the operator into a secondary encounter/loss of well clear

Test Method

- MANEUVER –*Follow HDG/ALT/VS bands to stay well clear*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec

Success Criteria

- Data collected from MACS display (see data requirements)
- Encounter causes DAIDALUS to provide preventive/corrective guidance
- UAS operator follows DAIDAULUS guidance

Expected Results

Ownship alerting

- Progress from no factor to corrective guidance
- Guidance will indicate a vertical solution to remain well clear.
- Guidance will not indicate a turn towards the secondary intruder

Additional Information

Follow Alt or VS bands to avoid intruder.
The closest point of approach (CPA) is 0.5NM for intruder 1
Intruder 2 should be on parallel path .7nm-1nm at same velocity as ownship

TEST OBJECTIVES

Demonstrate DAIDALUS will not guide UAS vertically into path of another known intruder.	**Section A.5.1 DAA MOPS / Version: July 28, 2015**

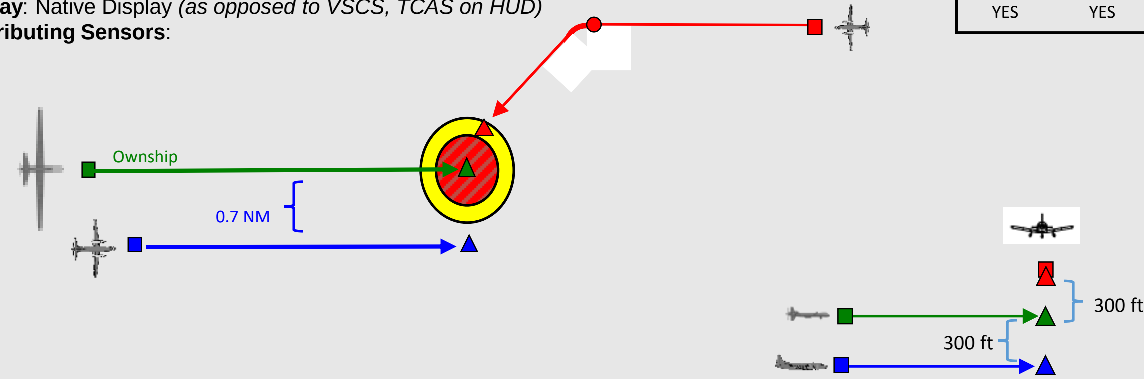
S38

Configuration

System Under Test: DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES



	Altitude
UAS	10000ft-20000ft
INT 1	10000ft-20000ft
INT 2	10000ft-20000ft

Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 400 ft

Scenario(s): #129

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting and guidance to the UAS operator.
2. SAA fusion processor correctly correlates tracks
3. Fly an encounter which blocks a descent maneuver

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:

- TO-1 Alerting shall progress from NO FACTOR, Proximate, preventive, corrective alerts
- DAIDALUS does not guide the operator into a secondary encounter/loss of well clear

Test Method

- MANEUVER –*Follow HDG/ALT/VS bands to stay well clear*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec

Success Criteria

- Data collected from MACS display (see data requirements)
- Encounter causes DAIDALUS to provide preventive/corrective guidance
- UAS operator follows DAIDAULUS guidance

Expected Results

Ownship alerting

- Progress from no factor to corrective guidance
- Guidance will indicate a vertical solution to remain well clear.
- Guidance will not indicate a turn towards the secondary intruder

Additional Information

Follow Alt or VS bands to avoid intruder.
The closest point of approach (CPA) is 0.5NM for intruder 1
Intruder 2 should be on parallel path .7nm-1nm at same velocity as ownship

TEST OBJECTIVES

Demonstrate DAIDALUS will not guide UAS vertically into path of another known intruder.	**Section A.5.1 DAA MOPS / Version: July 28, 2015**

Configuration

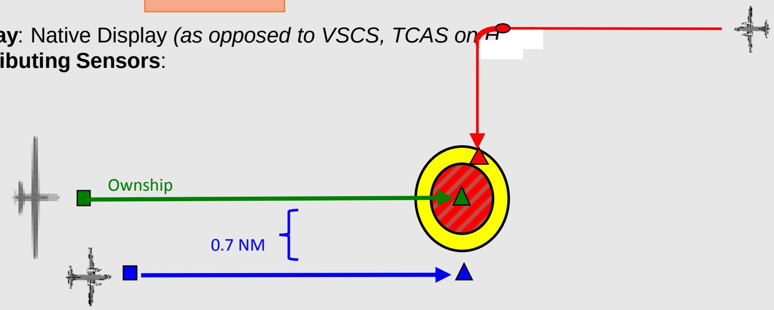
S38

System Under Test: DAIDALUS

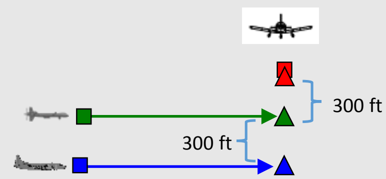
Display: Native Display *(as opposed to VSCS, TCAS on H*

Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES



	Altitude
UAS	10000ft-20000ft
INT 1	10000ft-20000ft
INT 2	10000ft-20000ft



Scenario(s): #130

Lateral Offset = 0.5 NM

SS Alerting Boundary = 0.75 NM

Minimum Altitude Offset ≥ 400 ft

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting and guidance to the UAS operator.
2. SAA fusion processor correctly correlates tracks
3. Fly an encounter which blocks a descent maneuver

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:

- TO-1 Alerting shall progress from NO FACTOR, Proximate, preventive, corrective alerts
- DAIDALUS does not guide the operator into a secondary encounter/loss of well clear

Test Method

- MANEUVER –*Follow HDG/ALT/VS bands to stay well clear*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec

Success Criteria

- Data collected from MACS display (see data requirements)
- Encounter causes DAIDALUS to provide preventive/corrective guidance
- UAS operator follows DAIDAULUS guidance

Expected Results

Ownship alerting

- Progress from no factor to corrective guidance
- Guidance will indicate a vertical solution to remain well clear.
- Guidance will not indicate a turn towards the secondary intruder

Additional Information

Follow Alt or VS bands to avoid intruder.
The closest point of approach (CPA) is 0.5NM for intruder 1
Intruder 2 should be on parallel path .7nm-1nm at same velocity as ownship

Well Clear Recovery

TEST OBJECTIVES

Demonstrate performance in a Head-on scenario.

Section A.5.1 DAA MOPS / Version: July 28, 2015

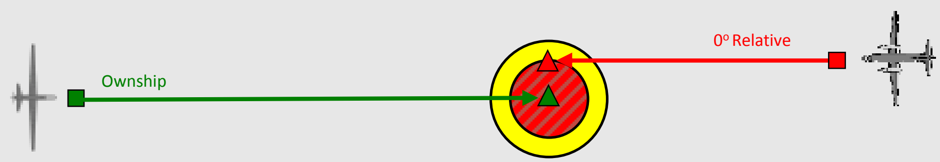
Configuration

S1

System Under Test: DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	NO	YES	YES



	Altitude
UAS	10000ft-20000ft
INT	10000ft-20000ft

Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 400 ft

Scenario(s): #131

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct well clear recovery guidance
2. SAA fusion processor correctly correlates tracks
3. Evaluate performance of well clear recovery guidance

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:

- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track
- Recovery guidance will show quickest time to recovery of well clear

Test Method

- MANEUVER –*Maneuver once well clear recovery guidance is displayed or at .7nm*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec
- DTHR: .7nm – 1nm

Success Criteria

- Data collected from MACS display (see data requirements)
- Well clear recovery guidance is displayed
- Operator follows well clear guidance

Expected Results

Ownship alerting

- Progress through each alerting condition
- Well clear recovery guidance provides options for shortest time to recover well clear from intruder

Additional Information

Fly into the encounter until recovery bands are displayed (typically just outside of well clear volume) or until prescribed distance

TEST OBJECTIVES

Demonstrate performance in Front-Quartering scenario. | **Section A.5.1 DAA MOPS / Version: July 28, 2015**

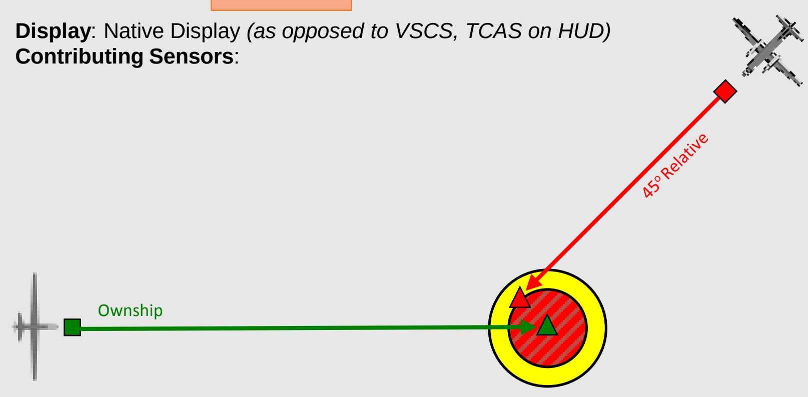
Configuration

S2

System Under Test DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	NO	YES	YES



	Altitude
UAS	10000ft-20000ft
INT	10000ft-20000ft

Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 400 ft

Scenario(s): #132

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct well clear recovery guidance
2. SAA fusion processor correctly correlates tracks
3. Evaluate performance of well clear recovery guidance

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:

- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track
- Recovery guidance will show quickest time to recovery of well clear

Test Method

- MANEUVER –*Maneuver once well clear recovery guidance is displayed or at .7nm*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec
- DTHR: .7nm – 1nm

Success Criteria

- Data collected from MACS display (see data requirements)
- Well clear recovery guidance is displayed
- Operator follows well clear guidance

Expected Results

Ownship alerting

- Progress through each alerting condition
- Well clear recovery guidance provides options for shortest time to recover well clear from intruder

Additional Information

Do not follow guidance. Follow predescribed path, hold constant altitude and speed.
The closest point of approach (CPA) is 0.5NM

TEST OBJECTIVES

Demonstrate performance in Crossing scenario.

Section A.5.1 DAA MOPS / Version: July 28, 2015

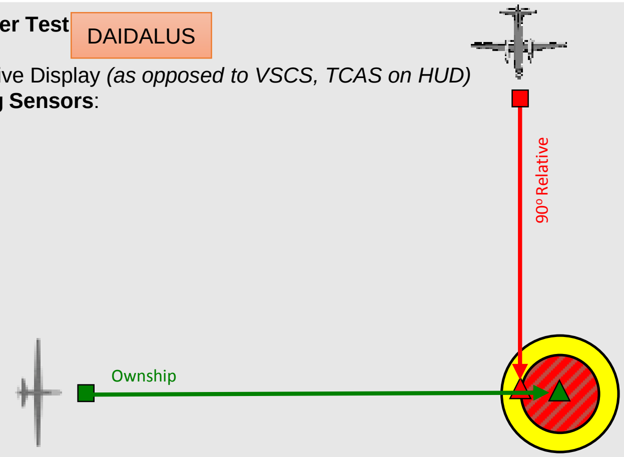
Configuration

System Under Test DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	NO	YES	YES

S3



	Altitude
UAS	10000ft-20000ft
INT	10000ft-20000ft

Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 400 ft

Scenario(s): #133

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct well clear recovery guidance
2. SAA fusion processor correctly correlates tracks
3. Evaluate performance of well clear recovery guidance

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:

- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track
- Recovery guidance will show quickest time to recovery of well clear

Test Method

- MANEUVER –*Maneuver once well clear recovery guidance is displayed or at .7nm*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec
- DTHR: .7nm – 1nm

Success Criteria

- Data collected from MACS display (see data requirements)
- Well clear recovery guidance is displayed
- Operator follows well clear guidance

Expected Results

Ownship alerting

- Progress through each alerting condition
- Well clear recovery guidance provides options for shortest time to recover well clear from intruder

Additional Information

Do not follow guidance. Follow predescribed path, hold constant altitude and speed.
The closest point of approach (CPA) is 0.5NM

TEST OBJECTIVES

Demonstrate performance in a Head-on scenario.	**Section A.5.1 DAA MOPS / Version: July 28, 2015**

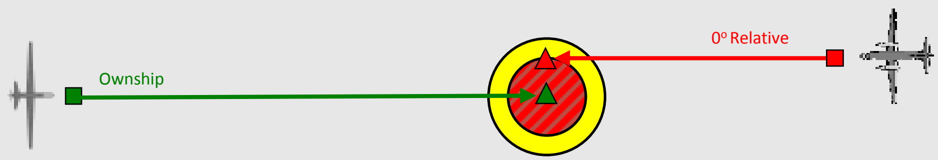
Configuration

System Under Test DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
NO	YES	YES	YES

S1



	Altitude
UAS	10000ft-20000ft
INT	10000ft-20000ft

Scenario(s): #136

Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 400 ft

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct well clear recovery guidance
2. SAA fusion processor correctly correlates tracks
3. Evaluate performance of well clear recovery guidance

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:

- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track
- Recovery guidance will show quickest time to recovery of well clear

Test Method

- MANEUVER –*Maneuver once well clear recovery guidance is displayed or at .7nm*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec
- DTHR: .7nm – 1nm

Success Criteria

- Data collected from MACS display (see data requirements)
- Well clear recovery guidance is displayed
- Operator follows well clear guidance

Expected Results

Ownship alerting

- Progress through each alerting condition
- Well clear recovery guidance provides options for shortest time to recover well clear from intruder

Additional Information

Do not follow guidance. Follow predescribed path, hold constant altitude and speed.
The closest point of approach (CPA) is 0.5NM

TEST OBJECTIVES

Demonstrate performance in Front-Quartering scenario.	Section A.5.1 DAA MOPS / Version: July 28, 2015

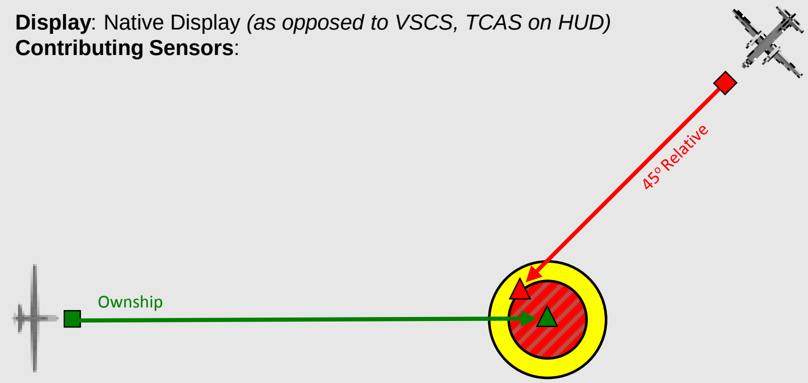
Configuration

System Under Test: DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
NO	YES	YES	YES

S2



Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 400 ft

	Altitude
UAS	10000ft-20000ft
INT	10000ft-20000ft

Scenario(s): #137

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct well clear recovery guidance
2. SAA fusion processor correctly correlates tracks
3. Evaluate performance of well clear recovery guidance

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:

- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track
- Recovery guidance will show quickest time to recovery of well clear

Test Method

- MANEUVER –*Maneuver once well clear recovery guidance is displayed or at .7nm*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec
- DTHR: .7nm – 1nm

Success Criteria

- Data collected from MACS display (see data requirements)
- Well clear recovery guidance is displayed
- Operator follows well clear guidance

Expected Results

Ownship alerting

- Progress through each alerting condition
- Well clear recovery guidance provides options for shortest time to recover well clear from intruder

Additional Information

Do not follow guidance. Follow predescribed path, hold constant altitude and speed.
The closest point of approach (CPA) is 0.5NM

TEST OBJECTIVES

Demonstrate performance in Crossing scenario.

Section A.5.1 DAA MOPS / Version: July 28, 2015

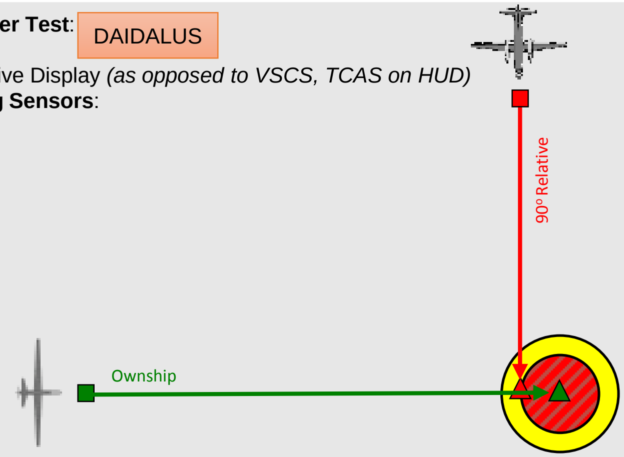
S3

Configuration

System Under Test: DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
NO	YES	YES	YES



Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 400 ft

	Altitude
UAS	10000ft-20000ft
INT	10000ft-20000ft

Scenario(s): #138

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct well clear recovery guidance
2. SAA fusion processor correctly correlates tracks
3. Evaluate performance of well clear recovery guidance

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:
- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track
- Recovery guidance will show quickest time to recovery of well clear

Test Method

- MANEUVER –*Maneuver once well clear recovery guidance is displayed or at .7nm*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec
- DTHR: .7nm – 1nm

Success Criteria

- Data collected from MACS display (see data requirements)
- Well clear recovery guidance is displayed
- Operator follows well clear guidance

Expected Results

Ownship alerting
- Progress through each alerting condition
- Well clear recovery guidance provides options for shortest time to recover well clear from intruder

Additional Information

Do not follow guidance. Follow predescribed path, hold constant altitude and speed.
The closest point of approach (CPA) is 0.5NM

TEST OBJECTIVES

Demonstrate performance in Rear-Quartering scenario.

Section A.5.1 DAA MOPS / Version: July 28, 2015

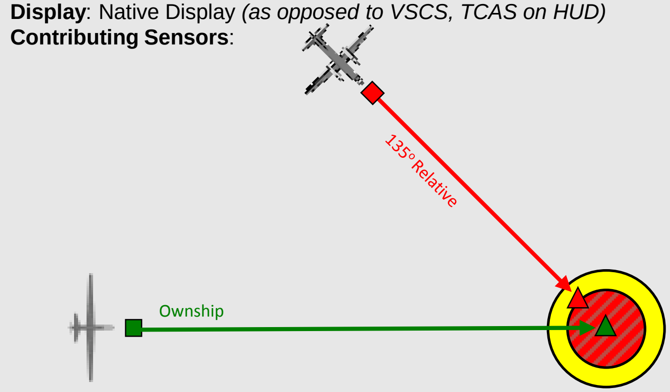
Configuration

S4

System Under Test DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
NO	YES	YES	YES



Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 400 ft

	Altitude
UAS	10000ft-20000ft
INT	10000ft-20000ft

Scenario(s): #139

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct well clear recovery guidance
2. SAA fusion processor correctly correlates tracks
3. Evaluate performance of well clear recovery guidance

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:
- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track
- Recovery guidance will show quickest time to recovery of well clear

Test Method

- MANEUVER –*Maneuver once well clear recovery guidance is displayed or at .7nm*
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec
- DTHR: .7nm – 1nm

Success Criteria

- Data collected from MACS display (see data requirements)
- Well clear recovery guidance is displayed
- Operator follows well clear guidance

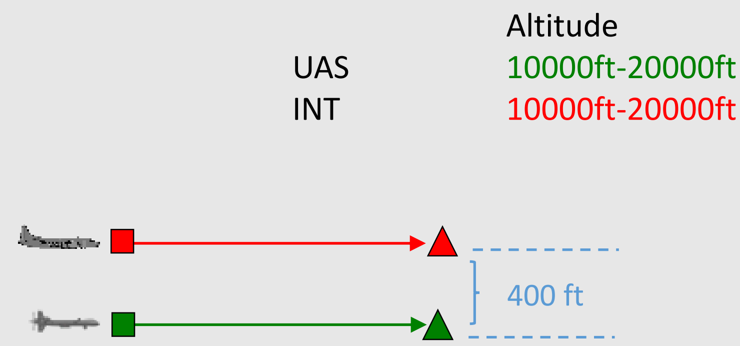
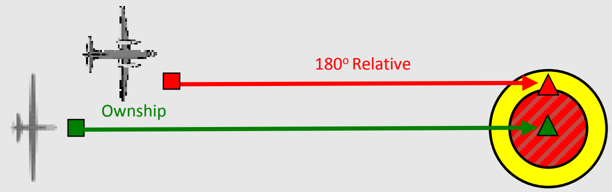
Expected Results

Ownship alerting
- Progress through each alerting condition
- Well clear recovery guidance provides options for shortest time to recover well clear from intruder

Additional Information

Do not follow guidance. Follow predescribed path, hold constant altitude and speed.
The closest point of approach (CPA) is 0.5NM

TEST OBJECTIVES

Demonstrate performance in Rear-Quartering scenario.	Section A.5.1 DAA MOPS / Version: July 28, 2015
Configuration **Scenario(s): #140**	**System Under Test** DAIDALUS **Display**: Native Display *(as opposed to VSCS, TCAS on HUD)* **Contributing Sensors**: | TCAS | ADS-B | Radar | Fusion | | NO | YES | YES | YES | **S4**   Lateral Offset = 0.5 NM SS Alerting Boundary = 0.75 NM Minimum Altitude Offset ≥ 400 ft
Test Objective (TO)	1. The DAIDALUS algorithm as displayed on the native display will show the correct well clear recovery guidance 2. SAA fusion processor correctly correlates tracks 3. Evaluate performance of well clear recovery guidance
Evaluation Criteria	The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following: • TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA… • TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track • Recovery guidance will show quickest time to recovery of well clear
Test Method	• MANEUVER –*Maneuver once well clear recovery guidance is displayed or at .7nm* • Encounter Length: 3 min • Stable Conditions: 2.5 min before CPA • Tolerance: ± 10 sec • DTHR: .7nm – 1nm
Success Criteria	• Data collected from MACS display (see data requirements) • Well clear recovery guidance is displayed • Operator follows well clear guidance
Expected Results	Ownship alerting • Progress through each alerting condition • Well clear recovery guidance provides options for shortest time to recover well clear from intruder
Additional Information	Do not follow guidance. Follow predescribed path, hold constant altitude and speed. The closest point of approach (CPA) is 0.5NM

Low Speed Intruders

TEST OBJECTIVES

Demonstrate performance in a Head-on scenario.

Section A.5.1 DAA MOPS / Version: July 28, 2015

Configuration

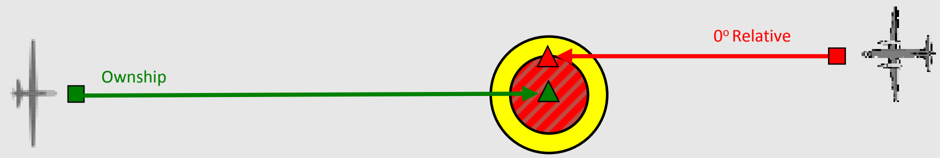
System Under Test: DAIDALUS

S1

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	NO	YES	YES

	Altitude
UAS	5000ft-20000ft
INT	5000ft-20000ft



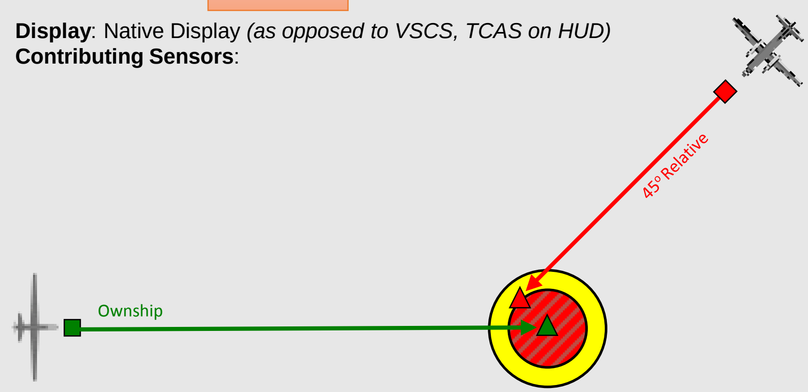
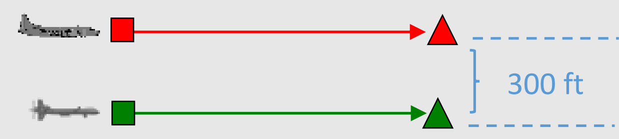
Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 400 ft

Scenario(s): #141

Test Objective (TO)	1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting to the UAS in a head-on scenario 2. SAA fusion processor correctly correlates tracks 3. DAIDALUS will account for low GS of intruder
Evaluation Criteria	The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the head-on intruder aircraft. DAIDALUS Display provides the following: • TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA… • TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track
Test Method	• MANEUVER –*Follow heading, Alt or VS bands* • Speed: ~100kgs • Encounter Length: 3 min • Stable Conditions: 2.5 min before CPA • Tolerance: ± 10 sec
Success Criteria	• Data collected from MACS display (see data requirements) • Encounter generates corrective self-separation alerts and guidance • Operator maneuvers in accordance with DAIDALUS guidance
Expected Results	Ownship alerting • Progress through each alerting condition • Corrective Self-separation guidance provides guidance away from intruder
Additional Information	Follow heading, Alt, or VS bands to remain well clear

TEST OBJECTIVES

Demonstrate performance in Front-Quartering scenario.	**Section A.5.1 DAA MOPS / Version: July 28, 2015**

Configuration **Scenario(s): #142**	**System Under Test** DAIDALUS **Display**: Native Display *(as opposed to VSCS, TCAS on HUD)* **Contributing Sensors**: S2 TCAS: YES; ADS-B: NO; Radar: YES; Fusion: YES  Lateral Offset = 0.5 NM SS Alerting Boundary = 0.75 NM Minimum Altitude Offset ≥ 400 ft Altitude UAS 5000ft-20000ft INT 5000ft-20000ft 
Test Objective (TO)	1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting to the UAS in a head-on scenario 2. SAA fusion processor correctly correlates tracks 3. DAIDALUS will account for low GS of intruder
Evaluation Criteria	The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the head-on intruder aircraft. DAIDALUS Display provides the following: • TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA… • TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track
Test Method	• MANEUVER –*Follow heading, Alt or VS bands* • Speed: ~100kgs • Encounter Length: 3 min • Stable Conditions: 2.5 min before CPA • Tolerance: ± 10 sec
Success Criteria	• Data collected from MACS display (see data requirements) • Encounter generates corrective self-separation alerts and guidance • Operator maneuvers in accordance with DAIDALUS guidance
Expected Results	Ownship alerting • Progress through each alerting condition • Corrective Self-separation guidance provides guidance away from intruder
Additional Information	Follow heading, Alt, or VS bands to remain well clear

TEST OBJECTIVES

Demonstrate performance in Crossing scenario.

Section A.5.1 DAA MOPS / Version: July 28, 2015

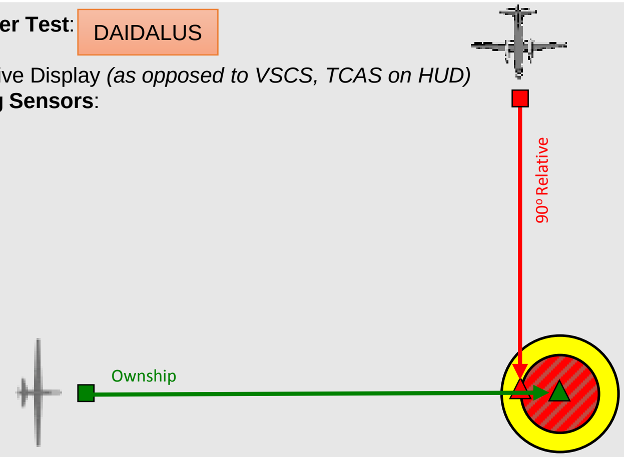
Configuration

System Under Test: DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	NO	YES	YES

S3



Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 400 ft

	Altitude
UAS	5000ft-20000ft
INT	5000ft-20000ft

Scenario(s): #143

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting to the UAS in a head-on scenario
2. SAA fusion processor correctly correlates tracks
3. DAIDALUS will account for low GS of intruder

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the head-on intruder aircraft. DAIDALUS Display provides the following:

- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track

Test Method

- MANEUVER –*Follow heading, Alt or VS bands*
- Speed: ~100kgs
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec

Success Criteria

- Data collected from MACS display (see data requirements)
- Encounter generates corrective self-separation alerts and guidance
- Operator maneuvers in accordance with DAIDALUS guidance

Expected Results

Ownship alerting

- Progress through each alerting condition
- Corrective Self-separation guidance provides guidance away from intruder

Additional Information

Follow heading, Alt, or VS bands to remain well clear

TEST OBJECTIVES

Demonstrate performance in a Head-on scenario.	**Section A.5.1 DAA MOPS / Version: July 28, 2015**

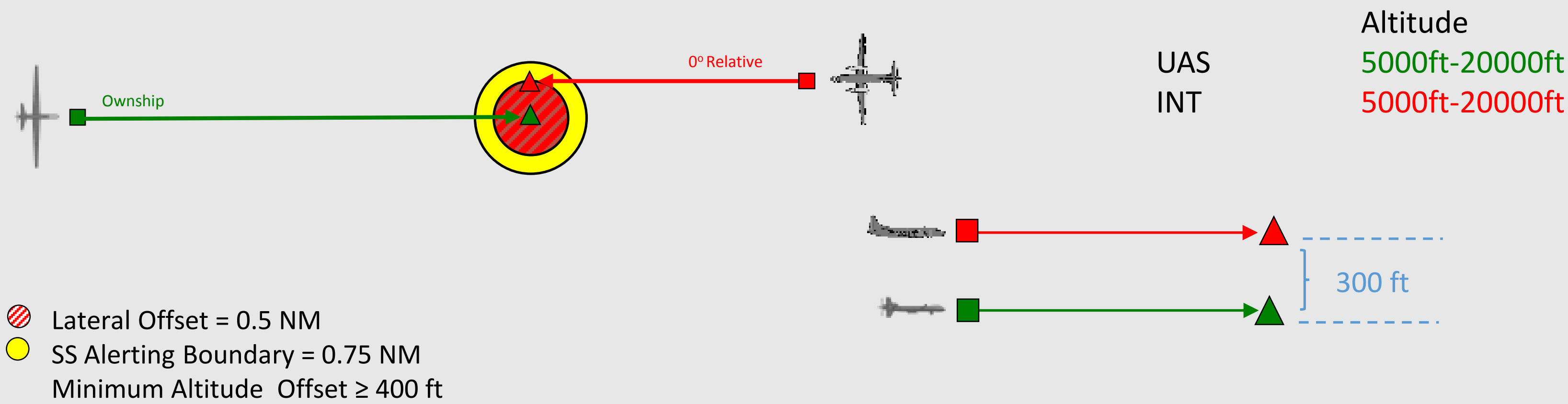
S1

Configuration

System Under Test: DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES



Scenario(s): #144

Test Objective (TO)	1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting to the UAS in a head-on scenario 2. SAA fusion processor correctly correlates tracks 3. DAIDALUS will account for low GS of intruder
Evaluation Criteria	The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the head-on intruder aircraft. DAIDALUS Display provides the following: • TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA… • TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track
Test Method	• MANEUVER –*Follow heading, Alt or VS bands* • Speed: ~100kgs • Encounter Length: 3 min • Stable Conditions: 2.5 min before CPA • Tolerance: ± 10 sec
Success Criteria	• Data collected from MACS display (see data requirements) • Encounter generates corrective self-separation alerts and guidance • Operator maneuvers in accordance with DAIDALUS guidance
Expected Results	Ownship alerting • Progress through each alerting condition • Corrective Self-separation guidance provides guidance away from intruder
Additional Information	Follow heading, Alt, or VS bands to remain well clear

TEST OBJECTIVES

Demonstrate performance in Front-Quartering scenario.	Section A.5.1 DAA MOPS / Version: July 28, 2015

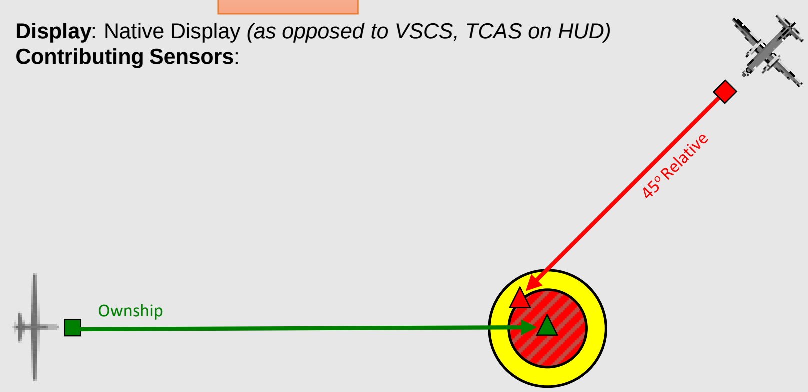
S2

Configuration

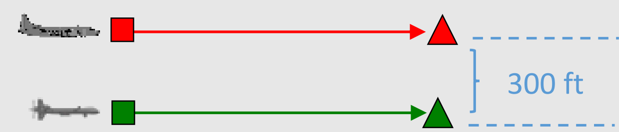
System Under Test: DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES



	Altitude
UAS	5000ft-20000ft
INT	5000ft-20000ft



Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 400 ft

Scenario(s): #145

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting to the UAS in a head-on scenario
2. SAA fusion processor correctly correlates tracks
3. DAIDALUS will account for low GS of intruder

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the head-on intruder aircraft. DAIDALUS Display provides the following:

- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track

Test Method

- MANEUVER –*Follow heading, Alt or VS bands*
- Speed: ~100kgs
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec

Success Criteria

- Data collected from MACS display (see data requirements)
- Encounter generates corrective self-separation alerts and guidance
- Operator maneuvers in accordance with DAIDALUS guidance

Expected Results

Ownship alerting

- Progress through each alerting condition
- Corrective Self-separation guidance provides guidance away from intruder

Additional Information

Follow heading, Alt, or VS bands to remain well clear

TEST OBJECTIVES

Demonstrate performance in Crossing scenario. | **Section A.5.1 DAA MOPS / Version: July 28, 2015**

Configuration

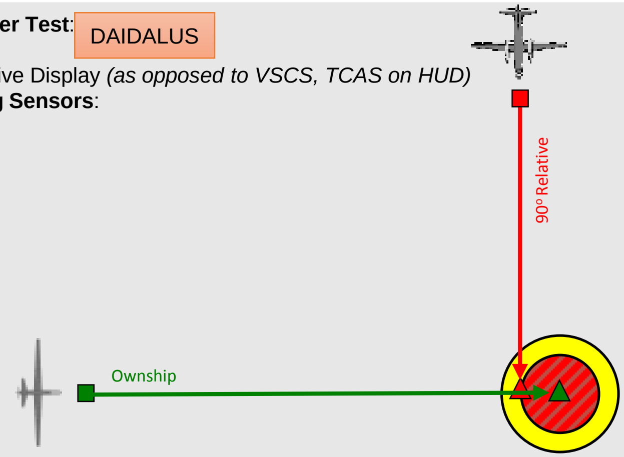
System Under Test: DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES

S3

	Altitude
UAS	5000ft-20000ft
INT	5000ft-20000ft



Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 400 ft

Scenario(s): #146

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting to the UAS in a head-on scenario
2. SAA fusion processor correctly correlates tracks
3. DAIDALUS will account for low GS of intruder

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the head-on intruder aircraft. DAIDALUS Display provides the following:

- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track

Test Method

- MANEUVER –*Follow heading, Alt or VS bands*
- Speed: ~100kgs
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec

Success Criteria

- Data collected from MACS display (see data requirements)
- Encounter generates corrective self-separation alerts and guidance
- Operator maneuvers in accordance with DAIDALUS guidance

Expected Results

Ownship alerting

- Progress through each alerting condition
- Corrective Self-separation guidance provides guidance away from intruder

Additional Information

Follow heading, Alt, or VS bands to remain well clear

TEST OBJECTIVES

Demonstrate performance in Rear-Quartering scenario. | **Section A.5.1 DAA MOPS / Version: July 28, 2015**

Configuration

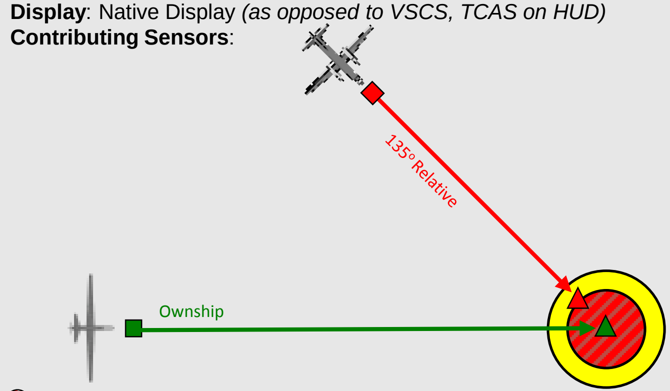
Scenario(s): #147

System Under Test DAIDALUS

S4

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES



Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 400 ft

	Altitude
UAS	5000ft-20000ft
INT	5000ft-20000ft

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting to the UAS in a head-on scenario
2. SAA fusion processor correctly correlates tracks
3. DAIDALUS will account for low GS of intruder

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the head-on intruder aircraft. DAIDALUS Display provides the following:
- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track

Test Method

- MANEUVER –*Follow heading, Alt or VS bands*
- Speed: ~100kgs
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec

Success Criteria

- Data collected from MACS display (see data requirements)
- Encounter generates corrective self-separation alerts and guidance
- Operator maneuvers in accordance with DAIDALUS guidance

Expected Results

Ownship alerting
- Progress through each alerting condition
- Corrective Self-separation guidance provides guidance away from intruder

Additional Information

Follow heading, Alt, or VS bands to remain well clear

Intruder Acceleration

TEST OBJECTIVES

Demonstrate performance in Front-Quartering scenario.	Section A.5.1 DAA MOPS / Version: July 28, 2015

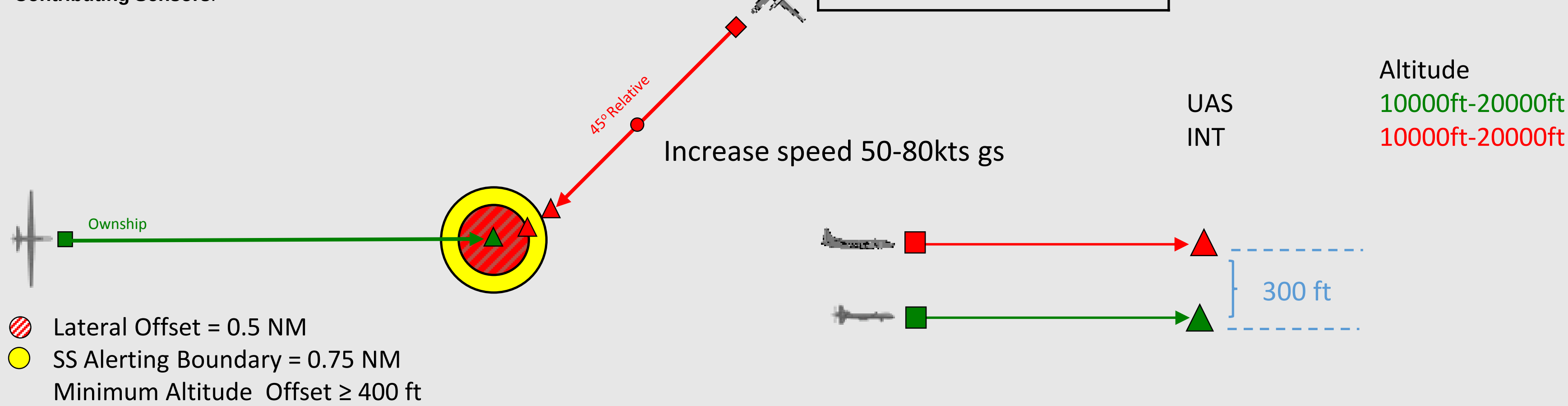
Configuration

System Under Test: DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	NO	YES	YES

S2



Scenario(s): #148

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting to the UAS in a front quartering scenario
2. SAA fusion processor correctly correlates tracks
3. DAIDALUS correctly accounts for increase in speed of intruder

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:

- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track
- DAIDALUS adjusts corrective guidance to account for updated intruder state information

Test Method

- MANEUVER –*Follow heading bands to remain well clear.*
- Intruder speed: Increase ground speed 50-80 kts ground speed to place CPA inside the well clear volume
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec

Success Criteria

- Data collected from MACS display (see data requirements)
- Intruder's CPA moves from outside the well clear volume to inside the well clear volume
- Appropriate corrective guidance is provided
- Operator maneuvers to remain well clear

Expected Results

Ownship alerting

- Progress through each alerting condition
- Guidance changes from proximate to corrective after intruder acceleration

Additional Information

Follow heading, alt or vs bands to remain well clear
The closest point of approach (CPA) before the increase in speed should be .7nm-1nm, CPA after speed increase should be .5nm

TEST OBJECTIVES

Demonstrate performance in Crossing scenario.

Section A.5.1 DAA MOPS / Version: July 28, 2015

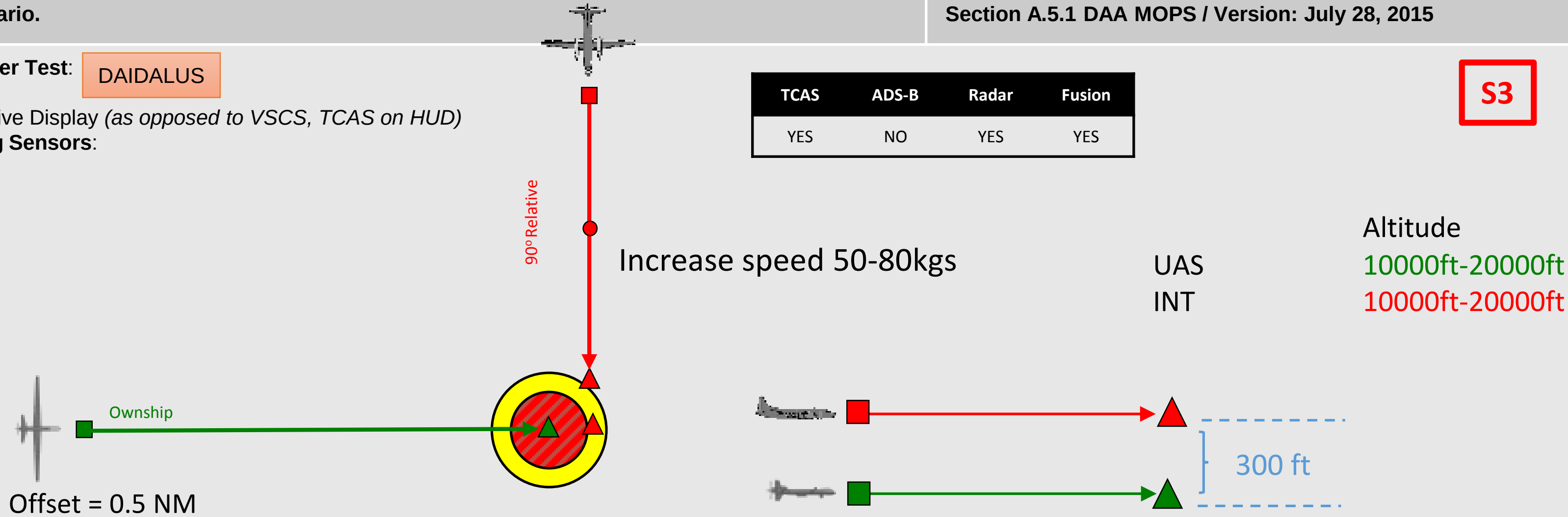
S3

Configuration

System Under Test: DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	NO	YES	YES



Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 400 ft

Scenario(s): #149

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting to the UAS in a front quartering scenario
2. SAA fusion processor correctly correlates tracks
3. DAIDALUS correctly accounts for increase in speed of intruder

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:
- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track
- DAIDALUS adjusts corrective guidance to account for updated intruder state information

Test Method

- MANEUVER –*Follow heading bands to remain well clear.*
- Intruder speed: Increase ground speed 50-80 kts ground speed to place CPA inside the well clear volume
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec

Success Criteria

- Data collected from MACS display (see data requirements)
- Intruder's CPA moves from outside the well clear volume to inside the well clear volume
- Appropriate corrective guidance is provided
- Operator maneuvers to remain well clear

Expected Results

Ownship alerting
- Progress through each alerting condition
- Guidance changes from proximate to corrective after intruder acceleration

Additional Information

Follow heading, alt or vs bands to remain well clear
The closest point of approach (CPA) before the increase in speed should be .7nm-1nm, CPA after speed increase should be .5nm

TEST OBJECTIVES

Demonstrate performance in Front-Quartering scenario.

Section A.5.1 DAA MOPS / Version: July 28, 2015

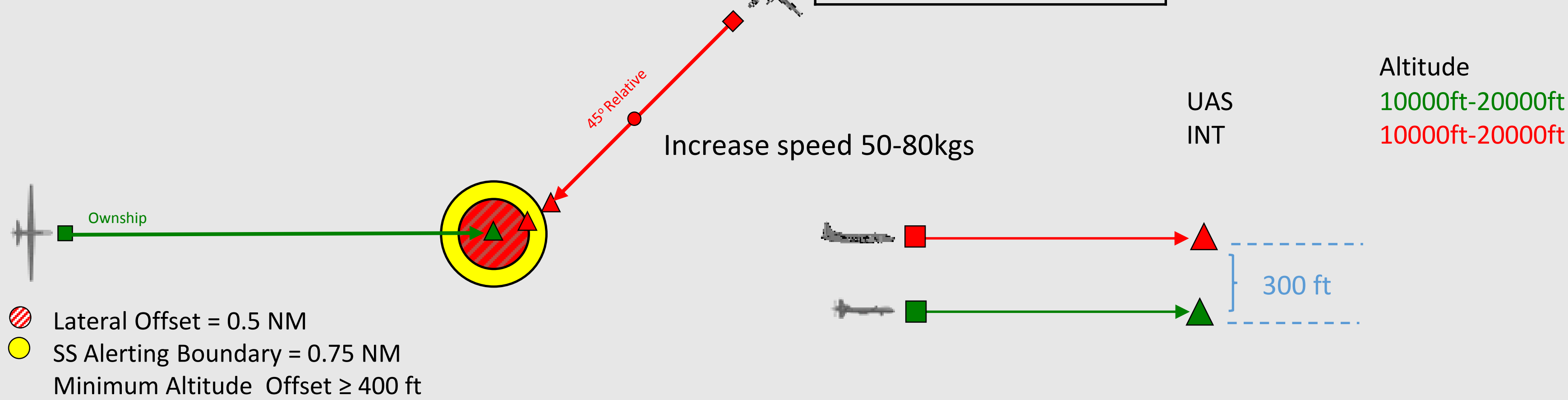
Configuration

System Under Test: DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES

S2



Scenario(s): #150

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting to the UAS in a front quartering scenario
2. SAA fusion processor correctly correlates tracks
3. DAIDALUS correctly accounts for increase in speed of intruder

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:
- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track
- DAIDALUS adjusts corrective guidance to account for updated intruder state information

Test Method

- MANEUVER –*Follow heading bands to remain well clear.*
- Intruder speed: Increase ground speed 50-80 kts ground speed to place CPA inside the well clear volume
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec

Success Criteria

- Data collected from MACS display (see data requirements)
- Intruder's CPA moves from outside the well clear volume to inside the well clear volume
- Appropriate corrective guidance is provided
- Operator maneuvers to remain well clear

Expected Results

Ownship alerting
- Progress through each alerting condition
- Guidance changes from proximate to corrective after intruder acceleration

Additional Information

Follow heading, alt or vs bands to remain well clear
The closest point of approach (CPA) before the increase in speed should be .7nm-1nm, CPA after speed increase should be .5nm

TEST OBJECTIVES

Demonstrate performance in Crossing scenario. | **Section A.5.1 DAA MOPS / Version: July 28, 2015**

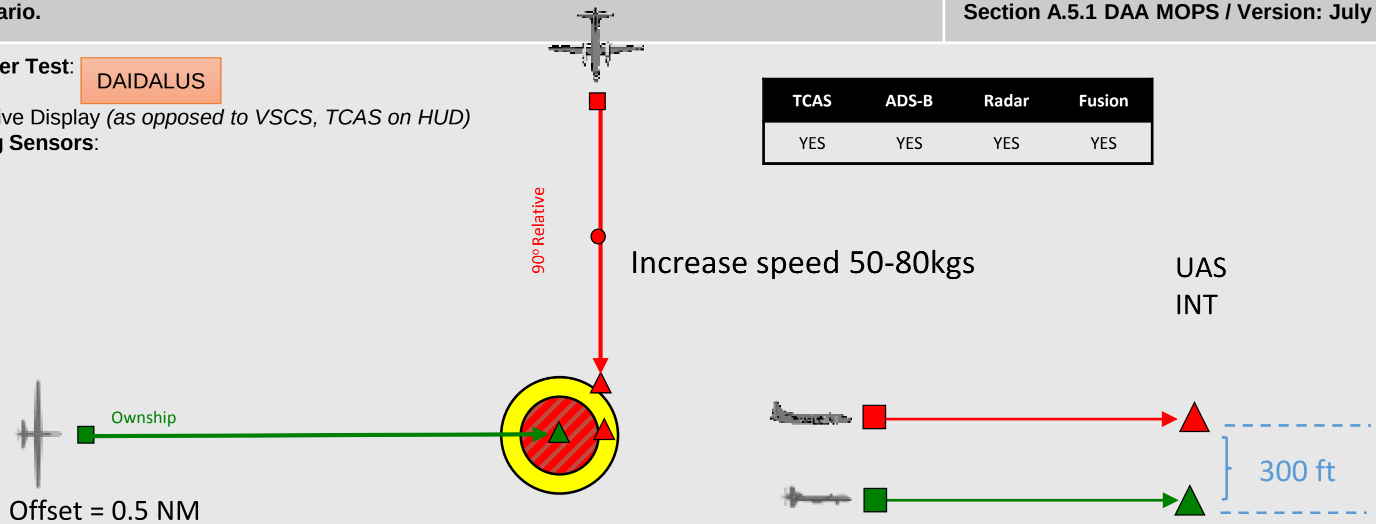
S3

Configuration

System Under Test: DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES



	Altitude
UAS	10000ft-20000ft
INT	10000ft-20000ft

Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 400 ft

Scenario(s): #151

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting to the UAS in a front quartering scenario
2. SAA fusion processor correctly correlates tracks
3. DAIDALUS correctly accounts for increase in speed of intruder

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:

- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track
- DAIDALUS adjusts corrective guidance to account for updated intruder state information

Test Method

- MANEUVER –*Follow heading bands to remain well clear.*
- Intruder speed: Increase ground speed 50-80 kts ground speed to place CPA inside the well clear volume
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec

Success Criteria

- Data collected from MACS display (see data requirements)
- Intruder's CPA moves from outside the well clear volume to inside the well clear volume
- Appropriate corrective guidance is provided
- Operator maneuvers to remain well clear

Expected Results

Ownship alerting

- Progress through each alerting condition
- Guidance changes from proximate to corrective after intruder acceleration

Additional Information

Follow heading, alt or vs bands to remain well clear
The closest point of approach (CPA) before the increase in speed should be .7nm-1nm, CPA after speed increase should be .5nm

TEST OBJECTIVES

Demonstrate performance in Rear-Quartering scenario.

Section A.5.1 DAA MOPS / Version: July 28, 2015

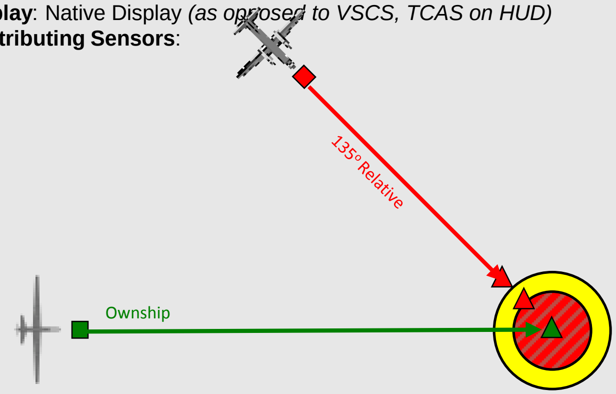
Configuration

System Under Test: DAIDALUS

S4

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES



	Altitude
UAS	10000ft-20000ft
INT	10000ft-20000ft

Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 400 ft

Scenario(s): #152

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting to the UAS in a front quartering scenario
2. SAA fusion processor correctly correlates tracks
3. DAIDALUS correctly accounts for increase in speed of intruder

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:

- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track
- DAIDALUS adjusts corrective guidance to account for updated intruder state information

Test Method

- MANEUVER –*Follow heading bands to remain well clear.*
- Intruder speed: Increase ground speed 50-80 kts ground speed to place CPA inside the well clear volume
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec

Success Criteria

- Data collected from MACS display (see data requirements)
- Intruder's CPA moves from outside the well clear volume to inside the well clear volume
- Appropriate corrective guidance is provided
- Operator maneuvers to remain well clear

Expected Results

Ownship alerting
- Progress through each alerting condition
- Guidance changes from proximate to corrective after intruder acceleration

Additional Information

Follow heading, alt or vs bands to remain well clear
The closest point of approach (CPA) before the increase in speed should be .7nm-1nm, CPA after speed increase should be .5nm

High Descent Rate

TEST OBJECTIVES

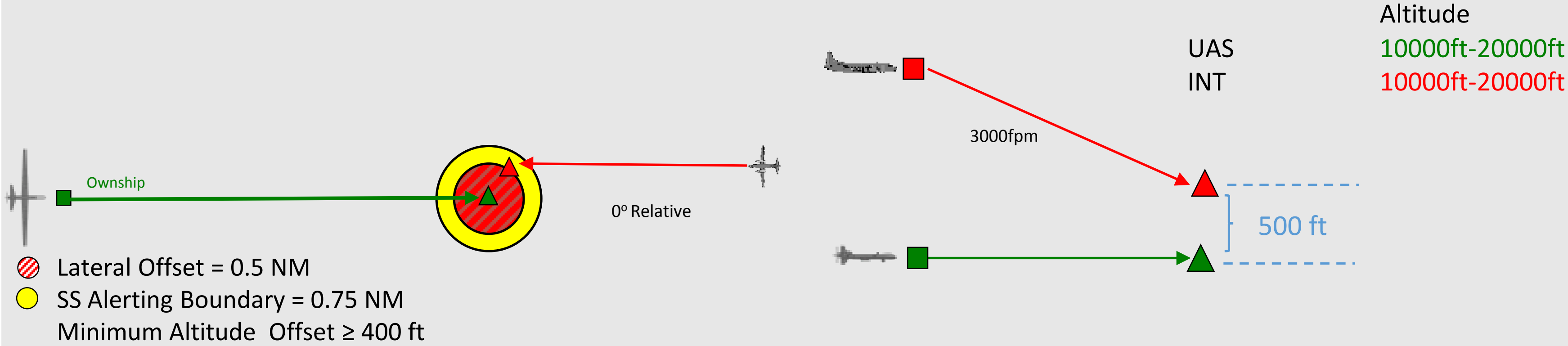
Demonstrate performance in Rear-Quartering scenario. | **Section A.5.1 DAA MOPS / Version: July 28, 2015**

Configuration

System Under Test DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES



Scenario(s): #153

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting to the UAS in a rear-quartering scenario
2. SAA fusion processor correctly correlates tracks
3. Evaluate effectiveness of Time to Co-Altitude variable on alerting

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:
- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track

Test Method

- MANEUVER –*Follow heading , VS, or Alt bands*
- Intruder VS: 3000fpm
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec
- TCOA: 0

Success Criteria

- Data collected from MACS display (see data requirements)
- Corrective self separation guidance is provided
- Intruder reaches 3000fpm
- Operator maneuvers to stay well clear

Expected Results

Ownship alerting
- Progress through each alerting condition
- Alerting and guidance shown earlier when TCOA is 20

Additional Information

Follow heading or vertical bands

TEST OBJECTIVES

Demonstrate performance in Rear-Quartering scenario.	Section A.5.1 DAA MOPS / Version: July 28, 2015

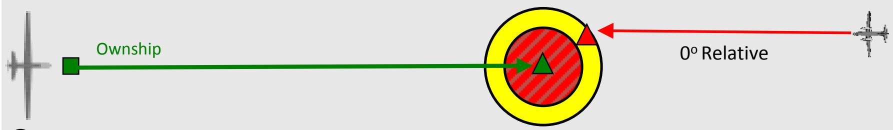
Configuration

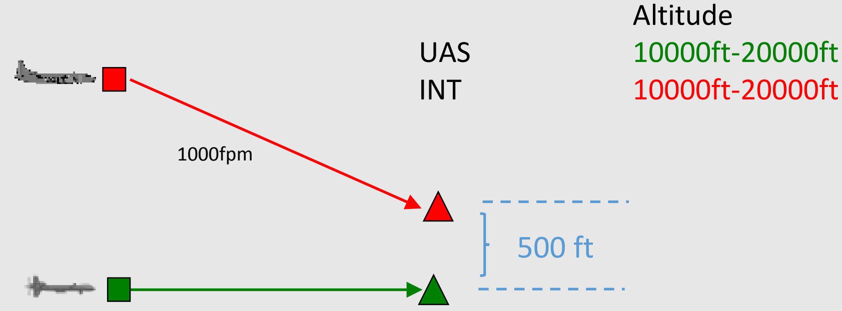
System Under Test DAIDALUS

S4

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES





Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 400 ft

Scenario(s): #154

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting to the UAS in a rear-quartering scenario
2. SAA fusion processor correctly correlates tracks
3. Evaluate effectiveness of Time to Co-Altitude variable on alerting

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:
- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track

Test Method

- MANEUVER –*Follow heading , VS, or Alt bands*
- Intruder VS: 1000fpm
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec
- TCOA: 0

Success Criteria

- Data collected from MACS display (see data requirements)
- Corrective self separation guidance is provided
- Intruder reaches 3000fpm
- Operator maneuvers to stay well clear

Expected Results

Ownship alerting
- Progress through each alerting condition
- Alerting and guidance shown earlier when TCOA is 20

Additional Information

Do not follow guidance. Follow predescribed path, hold constant altitude and speed.
The closest point of approach (CPA) is 0.5NM

TEST OBJECTIVES

Demonstrate performance in Rear-Quartering scenario. | **Section A.5.1 DAA MOPS / Version: July 28, 2015**

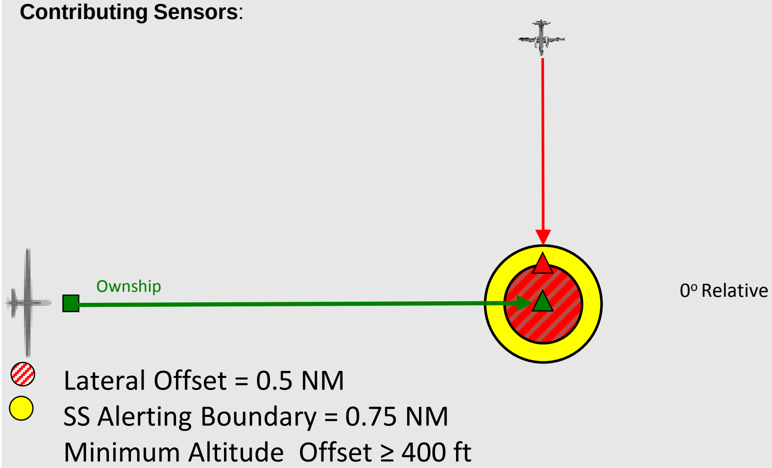
S4

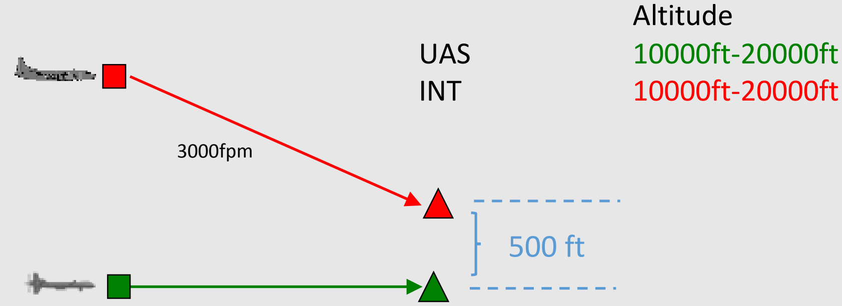
Configuration

System Under Test: DAIDALUS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES





Scenario(s): #157

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting to the UAS in a rear-quartering scenario
2. SAA fusion processor correctly correlates tracks
3. Evaluate effectiveness of Time to Co-Altitude variable on alerting

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:

- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track

Test Method

- MANEUVER –*Follow heading , VS, or Alt bands*
- Intruder VS: 3000fpm
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec
- TCOA: 0

Success Criteria

- Data collected from MACS display (see data requirements)
- Corrective self separation guidance is provided
- Intruder reaches 3000fpm
- Operator maneuvers to stay well clear

Expected Results

Ownship alerting

- Progress through each alerting condition
- Alerting and guidance shown earlier when TCOA is 20

Additional Information

Do not follow guidance. Follow predescribed path, hold constant altitude and speed.
The closest point of approach (CPA) is 0.5NM

TEST OBJECTIVES

Demonstrate performance in Rear-Quartering scenario. | **Section A.5.1 DAA MOPS / Version: July 28, 2015**

Configuration

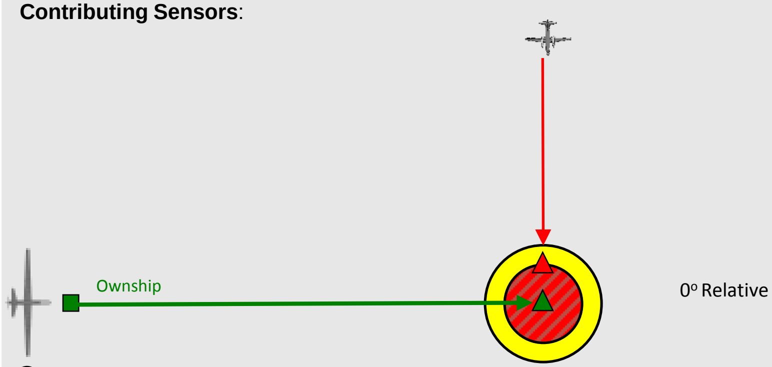
Scenario(s): #158

System Under Test: DAIDALUS

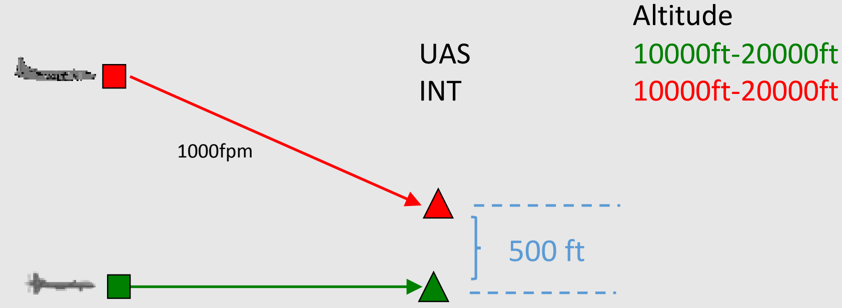
Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES

S4



Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 400 ft



Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting to the UAS in a rear-quartering scenario
2. SAA fusion processor correctly correlates tracks
3. Evaluate effectiveness of Time to Co-Altitude variable on alerting

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:

- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track

Test Method

- MANEUVER –*Follow heading , VS, or Alt bands*
- Intruder VS: 1000fpm
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec
- TCOA: 0

Success Criteria

- Data collected from MACS display (see data requirements)
- Corrective self separation guidance is provided
- Intruder reaches 3000fpm
- Operator maneuvers to stay well clear

Expected Results

Ownship alerting

- Progress through each alerting condition
- Alerting and guidance shown earlier when TCOA is 20

Additional Information

Do not follow guidance. Follow predescribed path, hold constant altitude and speed.
The closest point of approach (CPA) is 0.5NM

TEST OBJECTIVES

Demonstrate performance in Rear-Quartering scenario.	Section A.5.1 DAA MOPS / Version: July 28, 2015

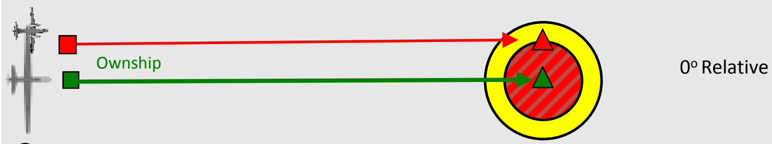
Configuration

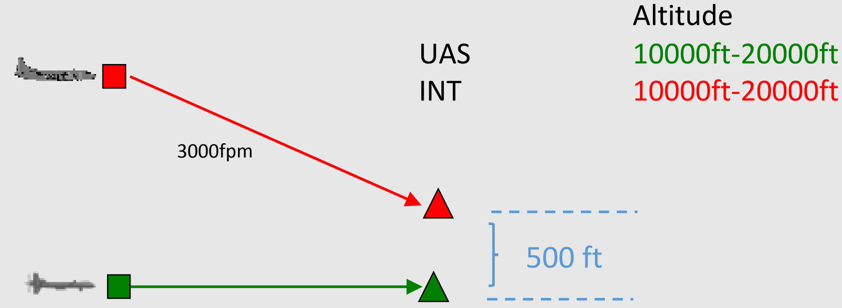
System Under Test: DAIDALUS

S4

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	NO	YES





Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 400 ft

Scenario(s): #163

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting to the UAS in a rear-quartering scenario
2. SAA fusion processor correctly correlates tracks
3. Evaluate effectiveness of Time to Co-Altitude variable on alerting

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:

- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track

Test Method

- MANEUVER –*Follow heading , VS, or Alt bands*
- Intruder VS: 3000fpm
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec
- TCOA: 20

Success Criteria

- Data collected from MACS display (see data requirements)
- Corrective self separation guidance is provided
- Intruder reaches 3000fpm
- Operator maneuvers to stay well clear

Expected Results

Ownship alerting

- Progress through each alerting condition
- Ownship maneuvers away from encounter prior to TCAS-RA and then maneuvers back to course

Show images of expected alerting

Additional Information

Do not follow guidance. Follow predescribed path, hold constant altitude and speed.
The closest point of approach (CPA) is 0.5NM

TEST OBJECTIVES

Demonstrate performance in Rear-Quartering scenario.

Section A.5.1 DAA MOPS / Version: July 28, 2015

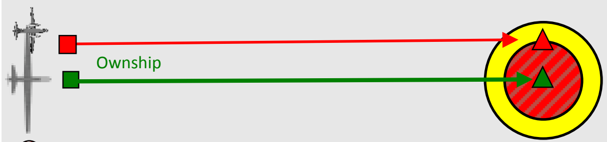
S4

Configuration

System Under Test: DAIDALUS

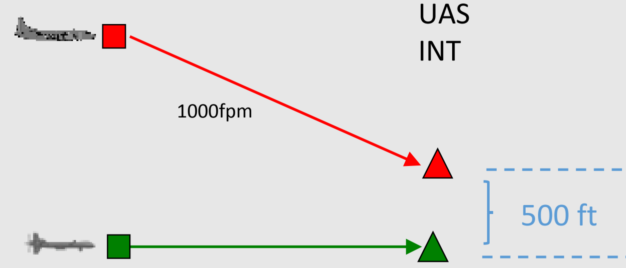
Display: Native Display *(as opposed to VSCS, TCAS on HUD)*
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	NO	YES



0º Relative

Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 400 ft



	Altitude
UAS	10000ft-20000ft
INT	10000ft-20000ft

Scenario(s): #164

Test Objective (TO)

1. The DAIDALUS algorithm as displayed on the native display will show the correct alerting to the UAS in a rear-quartering scenario
2. SAA fusion processor correctly correlates tracks
3. Evaluate effectiveness of Time to Co-Altitude variable on alerting

Evaluation Criteria

The alerting displayed to the UAS will provide adequate SA to the UAS Pilot Operator as to the status of the intruder aircraft. DAIDALUS Display provides the following:
- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA…
- TO-2 TCAS and ADS-B tracks are correctly fused into 1 single track

Test Method

- MANEUVER –*Follow heading , VS, or Alt bands*
- Intruder VS: 1000fpm
- Encounter Length: 3 min
- Stable Conditions: 2.5 min before CPA
- Tolerance: ± 10 sec
- TCOA: 20

Success Criteria

- Data collected from MACS display (see data requirements)
- Corrective self separation guidance is provided
- Intruder reaches 3000fpm
- Operator maneuvers to stay well clear

Expected Results

Ownship alerting
- Progress through each alerting condition
- Ownship maneuvers away from encounter prior to TCAS-RA and then maneuvers back to course

Show images of expected alerting

Additional Information

Do not follow guidance. Follow predescribed path, hold constant altitude and speed.
The closest point of approach (CPA) is 0.5NM

UAS in the NAS
FT4 Test Objectives
CPDS
Version 3, Feb. 1, 2016

TEST OBJECTIVES

S/N 165 DAA guidance against non-cooperative intruder being detected during ownship DAA maneuver | **Section 2.2.4. DAA MOPS / Version: July 28, 2015**

Configuration

System Under Test: CPDS

Display: CPDS CDTI and VPD

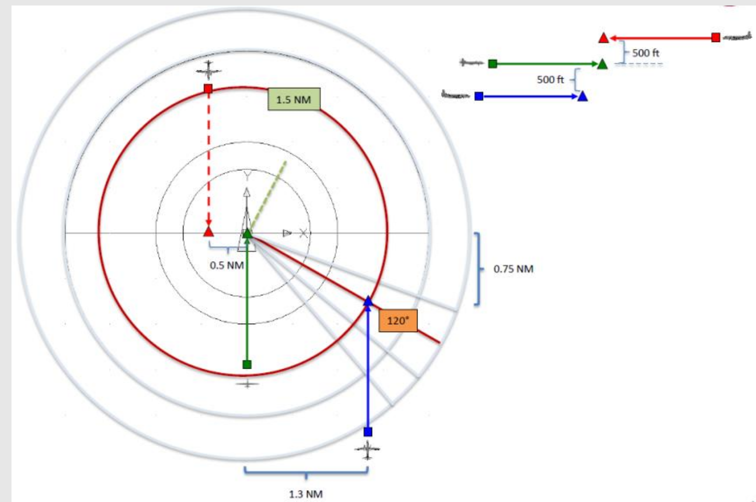
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	NO

Ownship: TCAS in TARA mode
Intruder 2: ADS-B and TCAS

Selected traffic on Winconverter must be the ADS-B of the non-cooperative intruder

Synthetic ownship altitude offset of -500 ft



Scenario(s): #165

Test Objective (TO)

1. Obtain data that can be used to define the real boundaries (due to processing latencies etc.) of the space where a non-cooperative intruder will become detectable during an ownship turn.

Evaluation Criteria

- Relative location of intruder at the moment of detection
- Progression of DAA alert status
- Progression of detection during and after ownship turn

Test Method

- Ownship and intruder are in a stable relative formation described by range, bearing and altitude (1.5 nmi, 120 deg, -500 ft)
- Ownship changes heading 30 degrees using rate 1 turn in the direction which will get intruder into radar FOV
- Ownship continues on new heading until non-cooperative intruder is either
    - no longer detected or
    - DAA alert state has reverted to NORMAL or
    - UAS pilot deems maneuver required for safety
- Encounter Length: TBD
- Stable Conditions: stable relative formation described by range, bearing and altitude
- Tolerance: 0.1 nmi range and 2 degrees bearing

Success Criteria

- No detection of the non-cooperative intruder before ownship turn
- Detection of non-cooperative occurs during ownship turn
- Predicted DA Alert states occur
- A735B data recorded

Expected Results

Ownship alerting
- SSWA

Additional Information

Anything not covered above.

TEST OBJECTIVES

S/N 166 DAA guidance against non-cooperative intruder being detected during ownship DAA maneuver | **Section 2.2.4. DAA MOPS / Version: July 28, 2015**

Configuration

System Under Test: CPDS

Display: CPDS CDTI and VPD

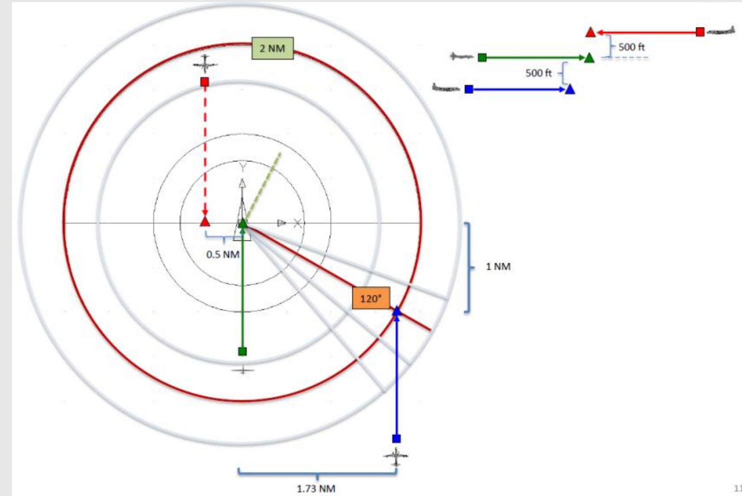
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	NO

Ownship: TCAS in TARA mode
Intruder 2: ADS-B and TCAS

Selected traffic on Winconverter must be the ADS-B of the non-cooperative intruder

Synthetic ownship altitude offset of -500 ft



Scenario(s): #166

Test Objective (TO)

1. Obtain data that can be used to define the real boundaries (due to processing latencies etc.) of the space where a non-cooperative intruder will become detectable during an ownship turn.

Evaluation Criteria

- Relative location of intruder at the moment of detection
- Progression of DAA alert status
- Progression of detection during and after ownship turn

Test Method

- Ownship and intruder are in a stable relative formation described by range, bearing and altitude (2.0 nmi, 120 deg, -500 ft)
- Ownship changes heading 30 degrees using rate 1 turn in the direction which will get intruder into radar FOV
- Ownship continues on new heading until non-cooperative intruder is either
    - no longer detected or
    - DAA alert state has reverted to NORMAL or
    - UAS pilot deems maneuver required for safety
- Encounter Length: TBD
- Stable Conditions: stable relative formation described by range, bearing and altitude
- Tolerance: 0.1 nmi range and 2 degrees bearing

Success Criteria

- No detection of the non-cooperative intruder before ownship turn
- Detection of non-cooperative occurs during ownship turn
- Predicted DA Alert states occur
- A735B data recorded

Expected Results

Ownship alerting
- SSWA

Additional Information

Anything not covered above.

TEST OBJECTIVES	
S/N 167 DAA guidance against non-cooperative intruder being detected during ownship DAA maneuver	**Section 2.2.4. DAA MOPS / Version: July 28, 2015**

Configuration

System Under Test: CPDS

Display: CPDS CDTI and VPD

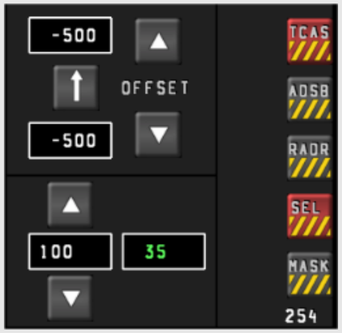
Contributing Sensors:

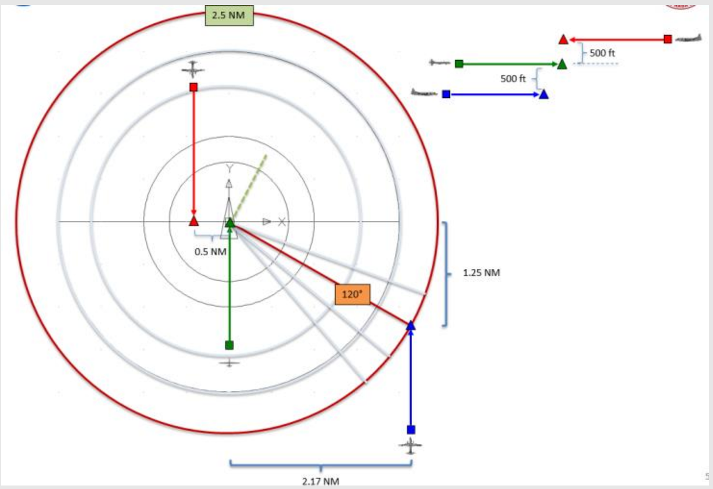
TCAS	ADS-B	Radar	Fusion
YES	YES	YES	NO

Ownship: TCAS in TARA mode
Intruder 2: ADS-B and TCAS

Selected traffic on Winconverter must be the ADS-B of the non-cooperative intruder

Synthetic ownship altitude offset of -500 ft





Scenario(s): #167

Test Objective (TO)	1. Obtain data that can be used to define the real boundaries (due to processing latencies etc.) of the space where a non-cooperative intruder will become detectable during an ownship turn.
Evaluation Criteria	• Relative location of intruder at the moment of detection • Progression of DAA alert status • Progression of detection during and after ownship turn

Test Method	• Ownship and intruder are in a stable relative formation described by range, bearing and altitude (2.5 nmi, 120 deg, -500 ft)
	• Ownship changes heading 30 degrees using rate 1 turn in the direction which will get intruder into radar FOV
	• Ownship continues on new heading until non-cooperative intruder is either
	    • no longer detected or
	    • DAA alert state has reverted to NORMAL or
	    • UAS pilot deems maneuver required for safety
	• Encounter Length: TBD
	• Stable Conditions: stable relative formation described by range, bearing and altitude
	• Tolerance: 0.1 nmi range and 2 degrees bearing

Success Criteria	• No detection of the non-cooperative intruder before ownship turn • Detection of non-cooperative occurs during ownship turn • Predicted DA Alert states occur • A735B data recorded
Expected Results	Ownship alerting • SSWA
Additional Information	Anything not covered above.

TEST OBJECTIVES

S/N 168 DAA guidance against non-cooperative intruder being detected during ownship DAA maneuver | **Section 2.2.4. DAA MOPS / Version: July 28, 2015**

Configuration

System Under Test: CPDS

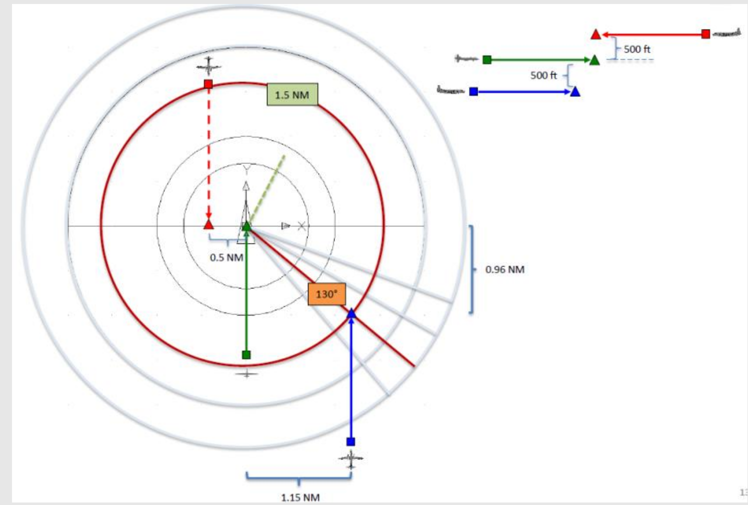
Display: CPDS CDTI and VPD
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	NO

Ownship: TCAS in TARA mode
Intruder 2: ADS-B and TCAS

Selected traffic on Winconverter must be the ADS-B of the non-cooperative intruder

Synthetic ownship altitude offset of -500 ft



Scenario(s): #168

Test Objective (TO)

1. Obtain data that can be used to define the real boundaries (due to processing latencies etc.) of the space where a non-cooperative intruder will become detectable during an ownship turn.

Evaluation Criteria

- Relative location of intruder at the moment of detection
- Progression of DAA alert status
- Progression of detection during and after ownship turn

Test Method

- Ownship and intruder are in a stable relative formation described by range, bearing and altitude (1.5 nmi, 130 deg, -500 ft)
- Ownship changes heading 30 degrees using rate 1 turn in the direction which will get intruder into radar FOV
- Ownship continues on new heading until non-cooperative intruder is either
  - no longer detected or
  - DAA alert state has reverted to NORMAL or
  - UAS pilot deems maneuver required for safety
- Encounter Length: TBD
- Stable Conditions: stable relative formation described by range, bearing and altitude
- Tolerance: 0.1 nmi range and 2 degrees bearing

Success Criteria

- No detection of the non-cooperative intruder before ownship turn
- Detection of non-cooperative occurs during ownship turn
- Predicted DA Alert states occur
- A735B data recorded

Expected Results

Ownship alerting
- SSWA

Additional Information

Anything not covered above.

TEST OBJECTIVES

S/N 169 DAA guidance against non-cooperative intruder being detected during ownship DAA maneuver | **Section 2.2.4. DAA MOPS / Version: July 28, 2015**

Configuration

System Under Test: CPDS

Display: CPDS CDTI and VPD

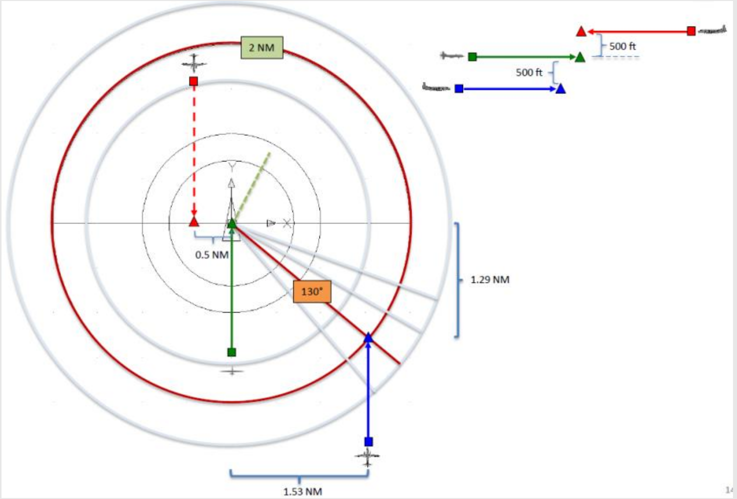
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	NO

Ownship: TCAS in TARA mode
Intruder 2: ADS-B and TCAS

Selected traffic on Winconverter must be the ADS-B of the non-cooperative intruder

Synthetic ownship altitude offset of -500 ft



Scenario(s): #169

Test Objective (TO)

1. Obtain data that can be used to define the real boundaries (due to processing latencies etc.) of the space where a non-cooperative intruder will become detectable during an ownship turn.

Evaluation Criteria

- Relative location of intruder at the moment of detection
- Progression of DAA alert status
- Progression of detection during and after ownship turn

Test Method

- Ownship and intruder are in a stable relative formation described by range, bearing and altitude (2.0 nmi, 130 deg, -500 ft)
- Ownship changes heading 30 degrees using rate 1 turn in the direction which will get intruder into radar FOV
- Ownship continues on new heading until non-cooperative intruder is either
    - no longer detected or
    - DAA alert state has reverted to NORMAL or
    - UAS pilot deems maneuver required for safety
- Encounter Length: TBD
- Stable Conditions: stable relative formation described by range, bearing and altitude
- Tolerance: 0.1 nmi range and 2 degrees bearing

Success Criteria

- No detection of the non-cooperative intruder before ownship turn
- Detection of non-cooperative occurs during ownship turn
- Predicted DA Alert states occur
- A735B data recorded

Expected Results

Ownship alerting
- SSWA

Additional Information

Anything not covered above.

TEST OBJECTIVES

S/N 170 DAA guidance against non-cooperative intruder being detected during ownship DAA maneuver

Section 2.2.4. DAA MOPS / Version: July 28, 2015

Configuration

System Under Test: CPDS

Display: CPDS CDTI and VPD

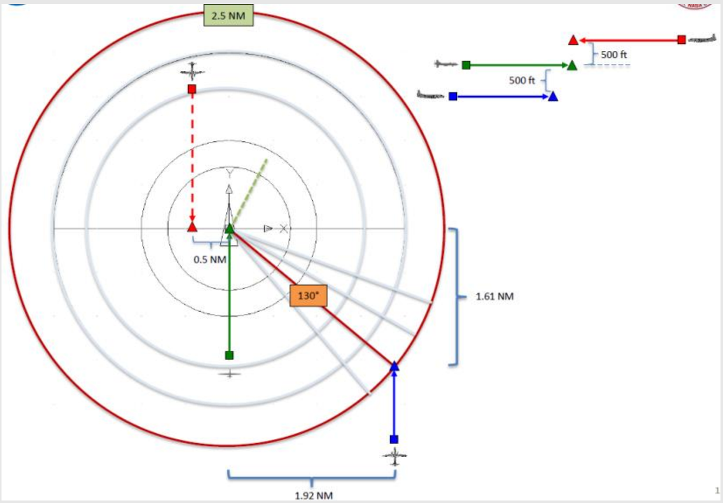
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	NO

Ownship: TCAS in TARA mode
Intruder 2: ADS-B and TCAS

Selected traffic on Winconverter must be the ADS-B of the non-cooperative intruder

Synthetic ownship altitude offset of -500 ft



Scenario(s): #170

Test Objective (TO)

1. Obtain data that can be used to define the real boundaries (due to processing latencies etc.) of the space where a non-cooperative intruder will become detectable during an ownship turn.

Evaluation Criteria

- Relative location of intruder at the moment of detection
- Progression of DAA alert status
- Progression of detection during and after ownship turn

Test Method

- Ownship and intruder are in a stable relative formation described by range, bearing and altitude (2.5 nmi, 130 deg, -500 ft)
- Ownship changes heading 30 degrees using rate 1 turn in the direction which will get intruder into radar FOV
- Ownship continues on new heading until non-cooperative intruder is either
    - no longer detected or
    - DAA alert state has reverted to NORMAL or
    - UAS pilot deems maneuver required for safety
- Encounter Length: TBD
- Stable Conditions: stable relative formation described by range, bearing and altitude
- Tolerance: 0.1 nmi range and 2 degrees bearing

Success Criteria

- No detection of the non-cooperative intruder before ownship turn
- Detection of non-cooperative occurs during ownship turn
- Predicted DA Alert states occur
- A735B data recorded

Expected Results

Ownship alerting
- SSWA

Additional Information

Anything not covered above.

TEST OBJECTIVES

S/N 171 Get data on Collision Avoidance Interoperability	**Section 2.2.4. DAA MOPS / Version: July 28, 2015**

Configuration

System Under Test: CPDS

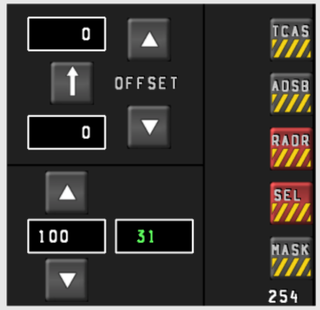
Display: CPDS CDTI and VPD

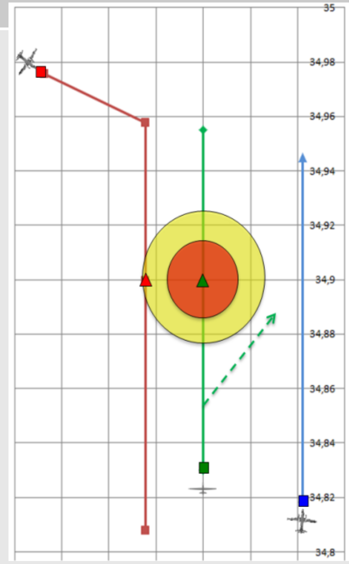
Contributing Sensors:

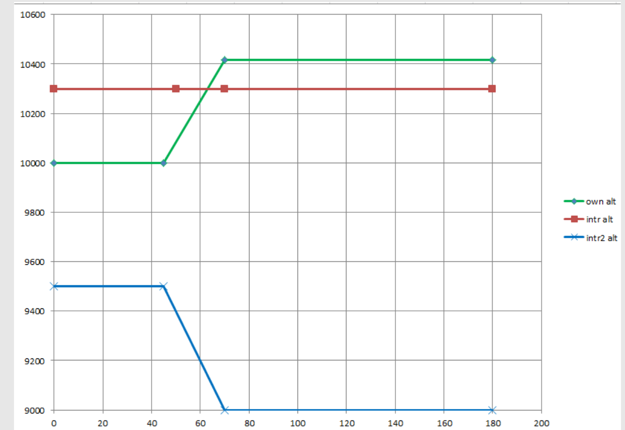
TCAS	ADS-B	Radar	Fusion
YES	YES	YES	NO

Ownship: TCAS in TARA mode
Intruder 1: ADS-B and TCAS
Intruder 2: ADS-B and TCAS

Selected traffic must be ADS-B of intruder 2







Scenario(s): #171

Test Objective (TO)	1. Obtain data on multi-intruder encounter in which ownship DAA maneuver results in a TCAS RA with another target.
Evaluation Criteria	• Timeliness, correctness, stability and persistence of the DAA alert states (2.2.4.2) • Timeliness, correctness, stability and persistence of the depicted conflict space (coasting) • Timeliness, correctness, stability and persistence of the depicted heading bands • Occurrence of (unexpected) overlapping alerts (2.2.4.4)
Test Method	• Encounter Length: 180 seconds • Intruder 1 trajectory triggers CSSA • Ownship turns to avoid loss of well clear and consequently triggers RA • Ownship follows RA • Tolerance: TBD
Success Criteria	• CSSA occurs with intruder 1 • Ownship maneuver prevents TCAS RA with intruder 1 • No loss of well clear occurs with intruder 1 • TCAS RA occurs with intruder 2 • A735B data recorded
Expected Results	Ownship alerting • CSSA with intruder 1 • TCAS RA with intruder 2
Additional Information	The ownship DAA maneuver does not result in a predictable endstate, i.e. an exact heading change. The geometry must be set up in such a way that the RA with intruder 2 will occur for a larger heading range beyond the minimum heading required to prevent a loss of well clear with intruder 1.

TEST OBJECTIVES

S/N 172 Get data on Collision Avoidance Interoperability	**Section 2.2.4. DAA MOPS / Version: July 28, 2015**

Configuration

System Under Test: CPDS

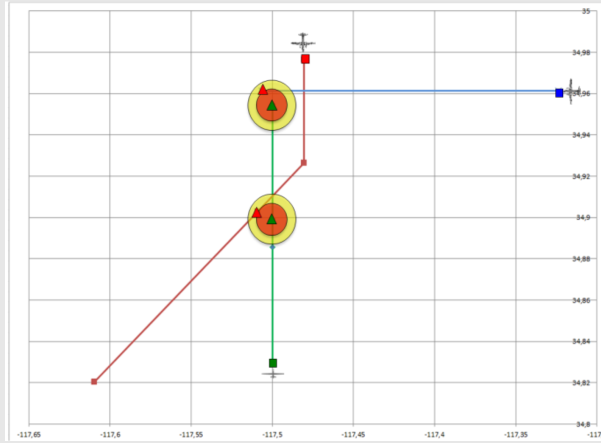
Display: CPDS CDTI and VPD

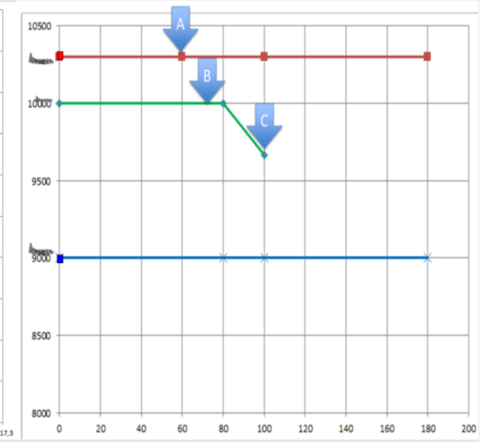
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES

Ownship: TCAS in TARA mode
Intruder 1: ADS-B and TCAS
Intruder 2: ADS-B and TCAS

On Winconverter, intruder 1 must be selected until RA
After RA, intruder 2 must be selected





Scenario(s): #172

Test Objective (TO)

1. Obtain data on multi-intruder encounter in which ownship TCAS RA maneuver against intruder triggers DAA CSSA for another target.

Evaluation Criteria

- Timeliness, correctness, stability and persistence of the DAA alert states (2.2.4.2)
- Timeliness, correctness, stability and persistence of the depicted conflict space
- Timeliness, correctness, stability and persistence of the depicted heading bands
- Occurrence of (unexpected) overlapping alerts (2.2.4.4)

Test Method

- Encounter Length: 180 seconds
- Intruder 1 horizontal maneuvers to trigger RA
- Ownship does not maneuver based on CSSA which may precede RA
- Ownship follows RA
- After clear of conflict from TCAS ownship uses DAA information to prevent loss of well clear
- Tolerance: TBD

Success Criteria

- No ownship maneuver before RA
- RA occurs as predicted
- Following RA triggers CSSA
- Ownship maneuver resolves CSSA and both targets become PSSA
- No SSWA occurs for intruder 2
- A735B data recorded

Expected Results

Ownship alerting
- TCAS descend RA with intruder 1
- CSSA with intruder 2
- No loss of well clear is expected to occur with intruder 2
- Ownship altitude change to around 9600 ft will make both intruders PSSA

Additional Information

Anything not covered above.

TEST OBJECTIVES

S/N 173 Get data on Collision Avoidance Interoperability | **Section 2.2.4. DAA MOPS / Version: July 28, 2015**

Configuration

System Under Test: CPDS

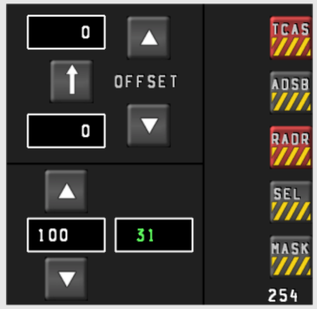
Display: CPDS CDTI and VPD

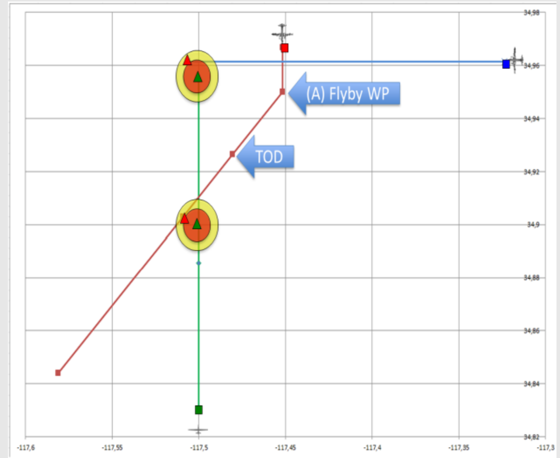
Contributing Sensors:

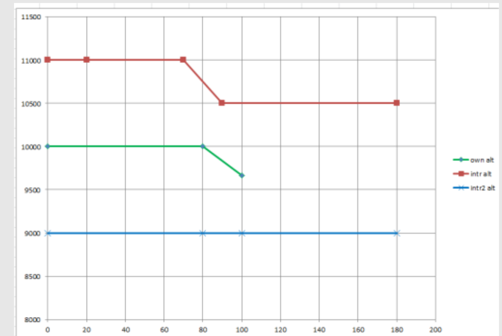
TCAS	ADS-B	Radar	Fusion
YES	YES	YES	NO

Ownship: TCAS in TARA mode
Intruder 1: ADS-B and TCAS
Intruder 2: ADS-B and TCAS

On Winconverter, intruder 1 must be selected until RA
After RA, intruder 2 must be selected







Scenario(s): #173

Test Objective (TO)

1. Obtain data on multi-intruder encounter in which ownship TCAS RA maneuver against intruder triggers DAA CSSA for another target.

Evaluation Criteria

- Timeliness, correctness, stability and persistence of the DAA alert states (2.2.4.2)
- Timeliness, correctness, stability and persistence of the depicted conflict space
- Timeliness, correctness, stability and persistence of the depicted heading bands
- Occurrence of (unexpected) overlapping alerts (2.2.4.4)

Test Method

- Encounter Length: 180 seconds
- Intruder 1 vertical maneuver to trigger RA
- Ownship does not maneuver based on CSSA which may precede RA
- Ownship follows RA
- After clear of conflict from TCAS ownship uses DAA information to prevent loss of well clear
- Tolerance: TBD

Success Criteria

- No ownship maneuver before RA
- RA occurs as predicted
- Following RA triggers CSSA
- Ownship maneuver resolves CSSA and both targets become PSSA
- No SSWA occurs for intruder 2
- A735B data recorded

Expected Results

Ownship alerting
- TCAS descend RA with intruder 1
- CSSA with intruder 2
- No loss of well clear is expected to occur with intruder 2
- Ownship altitude change to around 9600 ft will make both intruders PSSA

Additional Information

Anything not covered above.

TEST OBJECTIVES

S/N 174 Get data on Collision Avoidance Interoperability	Section 2.2.4. DAA MOPS / Version: July 28, 2015

Configuration

System Under Test: CPDS

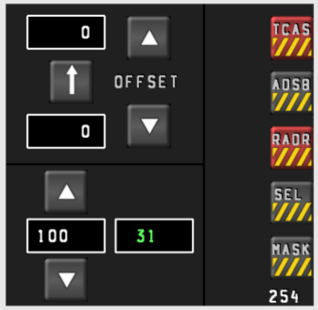
Display: CPDS CDTI and VPD

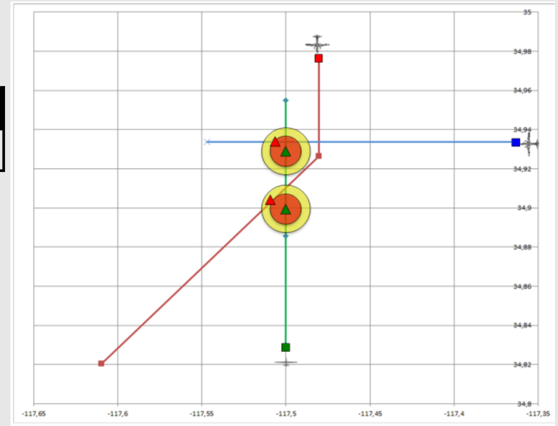
Contributing Sensors:

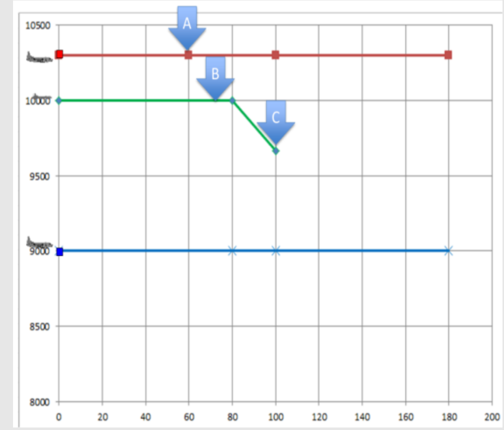
TCAS	ADS-B	Radar	Fusion
YES	YES	YES	NO

Ownship: TCAS in TARA mode
Intruder 1: ADS-B and TCAS
Intruder 2: ADS-B and TCAS

On Winconverter, intruder 2 must be selected







Scenario(s): #174

Test Objective (TO)	1. Obtain data on multi-intruder encounter in which ownship TCAS RA maneuver against intruder triggers DAA SSWA for another target.
Evaluation Criteria	• Timeliness, correctness, stability and persistence of the DAA alert states (2.2.4.2) • Timeliness, correctness, stability and persistence of the depicted conflict space • Timeliness, correctness, stability and persistence of the depicted heading bands • Occurrence of (unexpected) overlapping alerts (2.2.4.4)
Test Method	• Encounter Length: 180 seconds • Intruder 1 horizontal maneuvers to trigger RA • Ownship does not maneuver based on CSSA which may precede RA • Ownship follows RA • After clear of conflict from TCAS ownship uses DAA information to prevent loss of well clear or restore well clear • Tolerance: TBD
Success Criteria	• No ownship maneuver before RA • RA occurs as predicted • Following RA triggers SSWA • Ownship maneuver resolves SSWA • A735B data recorded
Expected Results	Ownship alerting • TCAS descend RA with intruder 1 • SSWA with intruder 2 • Loss of well clear likely to occur • Ownship returning to its altitude resolves SSWA
Additional Information	Anything not covered above.

TEST OBJECTIVES

S/N 175 Get data on Collision Avoidance Interoperability	Section 2.2.4. DAA MOPS / Version: July 28, 2015

Configuration

System Under Test: CPDS

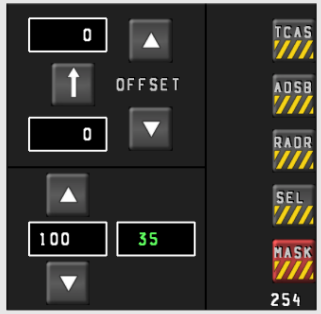
Display: CPDS CDTI and VPD

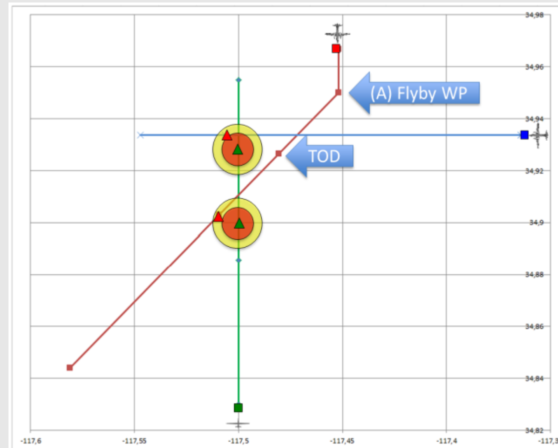
Contributing Sensors:

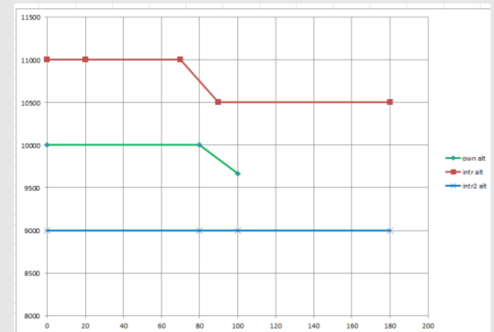
TCAS	ADS-B	Radar	Fusion
YES	YES	YES	YES

Ownship: TCAS in TARA mode
Intruder 1: ADS-B and TCAS
Intruder 2: ADS-B and TCAS

On Winconverter, intruder 2 must be selected







Scenario(s): #175

Test Objective (TO)

1. Obtain data on multi-intruder encounter in which ownship TCAS RA maneuver against intruder triggers DAA SSWA for another target.

Evaluation Criteria

- Timeliness, correctness, stability and persistence of the DAA alert states (2.2.4.2)
- Timeliness, correctness, stability and persistence of the depicted conflict space
- Timeliness, correctness, stability and persistence of the depicted heading bands
- Occurrence of (unexpected) overlapping alerts (2.2.4.4)

Test Method

- Encounter Length: 180 seconds
- Intruder 1 vertical maneuver to trigger RA
- Ownship does not maneuver based on CSSA which may precede RA
- Ownship follows RA
- After clear of conflict from TCAS ownship uses DAA information to prevent loss of well clear or restore well clear
- Tolerance: TBD

Success Criteria

- No ownship maneuver before RA
- RA occurs as predicted
- Following RA triggers SSWA
- Ownship maneuver resolves SSWA
- A735B data recorded

Expected Results

Ownship alerting
- TCAS descend RA with intruder 1
- SSWA with intruder 2
- Loss of well clear likely to occur
- Ownship returning to its altitude resolves SSWA

Additional Information

Anything not covered above.

National Aeronautics and Space Administration

UAS in the NAS
FT4 Test Objectives
(Radar)

TEST OBJECTIVES

GA Radar Statistical Run #1	Section DAA MOPS / Version: R4, R7, R9, R11, R13-16, R22-25,R28, R29, R30, R33, R34, R35

Configuration

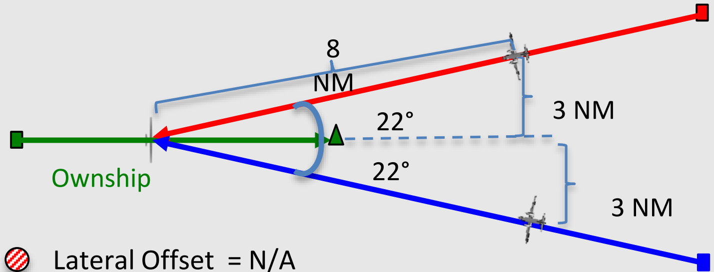
Scenario(s): #176

System Under Test: Radar

Display: CPDS

Contributing Sensors:

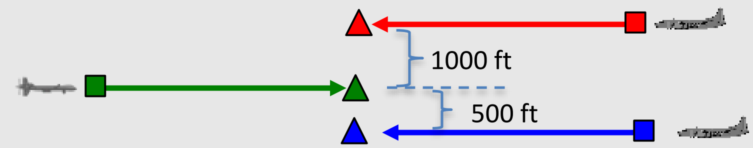
TCAS	ADS-B	Radar	Fusion
No	YES	YES	No



Lateral Offset = N/A

SS Alerting Boundary = N/A

Minimum Altitude Offset = 500ft



Intruder 1 Equipage: DGPS

Intruder 2 Equipage: DGPS

Test Objective (TO)	Track Radar Range and Accuracy against two intruders
Evaluation Criteria	Range and angular accuracy are within the limits defined in SC228. No track losses, track splits or false targets during the test.
Test Method	• MANEUVER: Ownship and Intruders fly without maneuver • Rel. Bearing: Intruder 1 = 0<IBA<30 , Intruder 2 = 0<IBA<-30 • Progressive Closure: Ownship = 160 KGS, Intruder 1 = 160 KGS, Intruder 2 = 160 KGS • Altitude: >10k MSL • Encounter Length: TBD min • Stable Conditions: TBD min before CPA • Climb Rate: 0 ft/min • Tolerance: TBD
Success Criteria	• Intruders are acquired at least at 8nm and from own ship and tracked until 1nm. Intruder aircrafts should maintain heading within ±5 degrees of the required heading.
Expected Results	Intruders are acquired at greater than 12 nm and tracked until 0.5nm, results should be comparable to ADS-B
Additional Information	Requirement: 16 scenarios 0<IBA<30

TEST OBJECTIVES

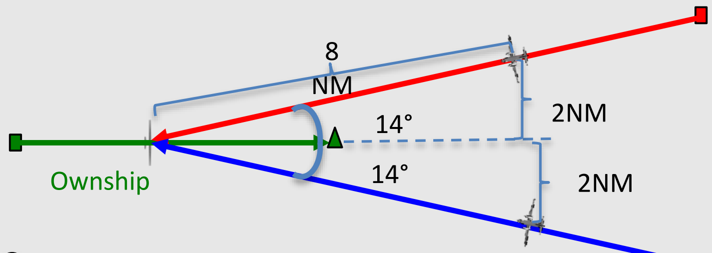
GA Radar Statistical Run #2	**Section DAA MOPS / Version: R4, R7, R9, R11, R13-16, R22-25,R28, R29, R30, R33, R34, R35**

Configuration

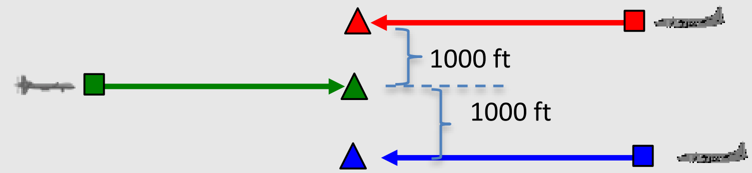
System Under Test: Radar

Display: CPDS
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
No	YES	YES	No



Lateral Offset = N/A
SS Alerting Boundary = N/A
Minimum Altitude Offset = 1000 ft



Intruder 1 Equipage: DGPS
Intruder 2 Equipage: DGPS

Scenario(s): #177

Test Objective (TO)	1. Track Radar Range and Accuracy against two intruders
Evaluation Criteria	Range and angular accuracy are within the limits defined in SC228. No track losses, track splits or false targets during the test.
Test Method	• MANEUVER: Ownship and Intruders fly without maneuver • Rel. Bearing: Intruder 1 = 0<IBA<30 , Intruder 2 = 0<IBA<-30 • Progressive Closure: Ownship = 160 KGS, Intruder 1 = 160 KGS, Intruder 2 = 160 KGS • Altitude: >10k MSL • Encounter Length: TBD min • Stable Conditions: TBD min before CPA • Climb Rate: 0 ft/min • Tolerance: TBD
Success Criteria	• Intruders are acquired at least at 8nm and from own ship and tracked until 1nm. Intruder aircrafts should maintain heading within $\pm$5 degrees of the required heading.
Expected Results	Intruders are acquired at greater than 12 nm and tracked until 0.5nm, results should be comparable to ADS-B
Additional Information	Requirement: 16 scenarios 0<IBA<30

TEST OBJECTIVES

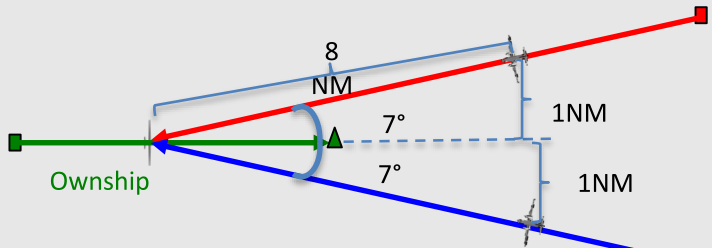
GA Radar Statistical Run #3	Section DAA MOPS / Version: R4, R7, R9, R11, R13-16, R22-25,R28, R29, R30, R33, R34, R35

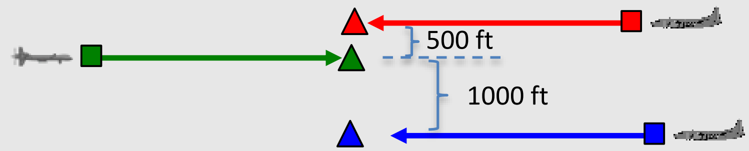
Configuration

System Under Test: Radar

Display: CPDS
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
No	YES	YES	No





Scenario(s): #178

Lateral Offset = N/A
SS Alerting Boundary = N/A
Minimum Altitude Offset = 500 ft

Intruder 1 Equipage: DGPS
Intruder 2 Equipage: DGPS

Test Objective (TO)	1. Track Radar Range and Accuracy against two intruders
Evaluation Criteria	Range and angular accuracy are within the limits defined in SC228. No track losses, track splits or false targets during the test.
Test Method	• MANEUVER: Ownship and Intruders fly without maneuver • Rel. Bearing: Intruder 1 = 0<IBA<30 , Intruder 2 = 0<IBA<-30 • Progressive Closure: Ownship = 160 KGS, Intruder 1 = 160 KGS, Intruder 2 = 160 KGS • Altitude: >10k MSL • Encounter Length: TBD min • Stable Conditions: TBD min before CPA • Climb Rate: 0 ft/min • Tolerance: TBD
Success Criteria	• Intruders are acquired at least at 8nm and from own ship and tracked until 1nm. Intruder aircrafts should maintain heading within $\pm$5 degrees of the required heading.
Expected Results	Intruders are acquired at greater than 12 nm and tracked until 0.5nm, results should be comparable to ADS-B
Additional Information	Requirement: 16 scenarios 0<IBA<30

TEST OBJECTIVES

GA Radar Statistical Run #4	Section DAA MOPS / Version: R4, R7, R9, R11, R13-16, R22-25,R28, R29, R30, R33, R34, R35

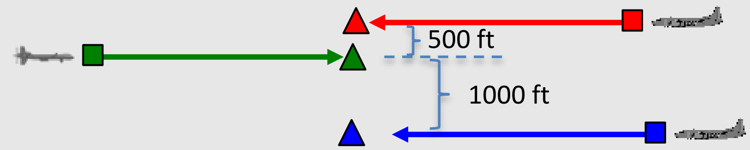
Configuration

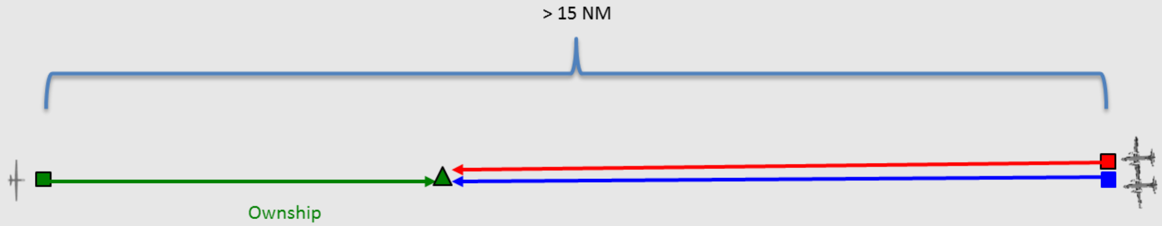
System Under Test: Radar

Display: CPDS

Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
No	YES	YES	No





Lateral Offset = N/A
SS Alerting Boundary = N/A
Minimum Altitude Offset = 500 ft

Intruder 1 Equipage: DGPS
Intruder 2 Equipage: DGPS

Scenario(s): #179

Test Objective (TO)

1. Track Radar Range and Accuracy against two intruders

Evaluation Criteria

Range and angular accuracy are within the limits defined in SC228. No track losses, track splits or false targets during the test.

Test Method

- MANEUVER: Ownship and Intruders fly without maneuver
- Rel. Bearing: Intruder 1 = 0<IBA<30 , Intruder 2 = 0<IBA<30
- Progressive Closure: Ownship = 160 KGS, Intruder 1 = 160 KGS, Intruder 2 = 160 KGS
- Altitude: >10k MSL
- Encounter Length: TBD min
- Stable Conditions: TBD min before CPA
- Climb Rate: 0 ft/min
- Tolerance: TBD

Success Criteria

- Intruders are acquired at least at 8nm and from own ship and tracked until 1nm. Intruder aircrafts should maintain heading within ±5 degrees of the required heading.

Expected Results

Intruders are acquired at greater than 12 nm and tracked until 0.5nm, results should be comparable to ADS-B

Additional Information

Requirement: 16 scenarios 0<IBA<30

TEST OBJECTIVES

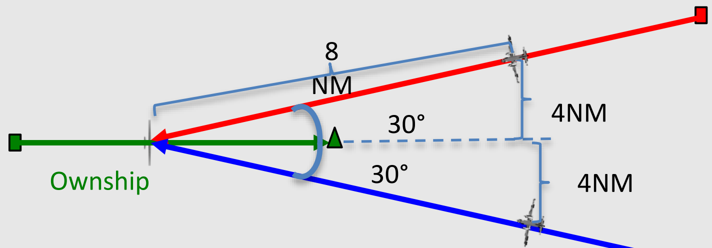
GA Radar Statistical Run #5	Section DAA MOPS / Version: R4, R7, R9, R11, R13-16, R22-25,R28, R29, R30, R33, R34, R35

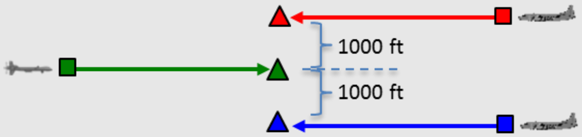
Configuration

System Under Test: Radar

Display: CPDS
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
No	YES	YES	No





Scenario(s): #180

Lateral Offset = N/A
SS Alerting Boundary = N/A
Minimum Altitude Offset = 1000 ft

Intruder 1 Equipage: DGPS
Intruder 2 Equipage: DGPS

Test Objective (TO)	1. Track Radar Range and Accuracy against two intruders
Evaluation Criteria	Range and angular accuracy are within the limits defined in SC228. No track losses, track splits or false targets during the test.
Test Method	• MANEUVER: Ownship and Intruders fly without maneuver • Rel. Bearing: Intruder 1 = 0<IBA<30 , Intruder 2 = 0<IBA<-30 • Progressive Closure: Ownship = 160 KGS, Intruder 1 = 160 KGS, Intruder 2 = 160 KGS • Altitude: >10k MSL • Encounter Length: TBD min • Stable Conditions: TBD min before CPA • Climb Rate: 0 ft/min • Tolerance: TBD
Success Criteria	• Intruders are acquired at least at 8nm and from own ship and tracked until 1nm. Intruder aircrafts should maintain heading within ±5 degrees of the required heading.
Expected Results	Intruders are acquired at greater than 12 nm and tracked until 0.5nm, results should be comparable to ADS-B
Additional Information	R4, R7, R9, R11, R13-16, R22-25,R28, R29, R30, R33, R34, R35

TEST OBJECTIVES

GA Radar Statistical Run #6

Section DAA MOPS / Version: R4, R7, R9, R11, R13-16, R22-25,R28, R29, R30, R33, R34, R35

Configuration

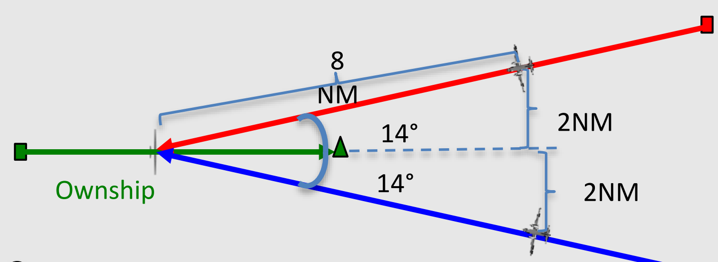
Scenario(s): #181

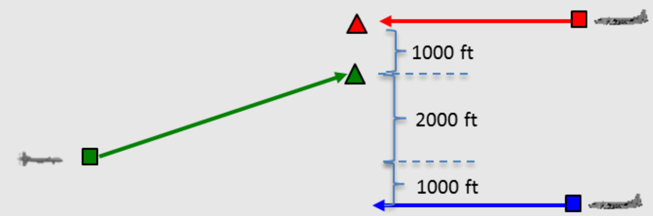
System Under Test: Radar

Display: CPDS

Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
No	YES	YES	No





Lateral Offset = N/A
SS Alerting Boundary = N/A
Minimum Altitude Offset ≥ 1000 ft.

Intruder 1 Equipage: DGPS
Intruder 2 Equipage: DGPS

Test Objective (TO)

1. Track Radar Range and Accuracy against two intruders

Evaluation Criteria

Range and angular accuracy are within the limits defined in SC228. No track losses, track splits or false targets during the test.

Test Method

- MANEUVER: Ownship climb , Intruders fly without maneuver
- Rel. Bearing: Intruder 1 = 0<IBA<30 , Intruder 2 = 0<IBA<-30
- Progressive Closure: Ownship = 160 KGS, Intruder 1 = 160 KGS, Intruder 2 = 160 KGS
- Altitude: ≥10k MSL
- Encounter Length: TBD min
- Stable Conditions: TBD min before CPA
- Climb Rate: TBD ft/min
- Tolerance: TBD

Success Criteria

- Intruders are acquired at least at 8nm and from own ship and tracked until 1nm or within Radar's FOV. Intruder aircrafts should maintain heading within $\pm$5 degrees of the required heading.

Expected Results

Intruders are acquired at greater than 12 nm and tracked until 0.5nm, results should be comparable to ADS-B
Target below the own ship will leave Radar's FOV earlier than target above ownship

Additional Information

Requirement: 16 scenarios 0<IBA<30

TEST OBJECTIVES

GA Radar Statistical Run #7

Section DAA MOPS / Version: R4, R7, R9, R11, R13-16, R22-25,R28, R29, R30, R33, R34, R35

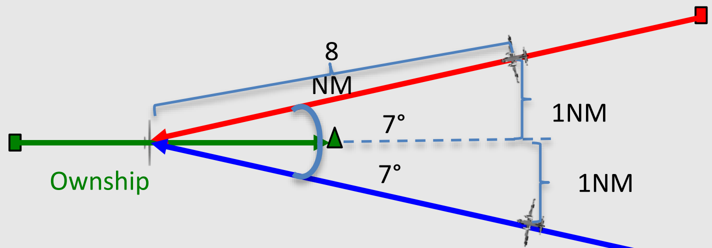
Configuration

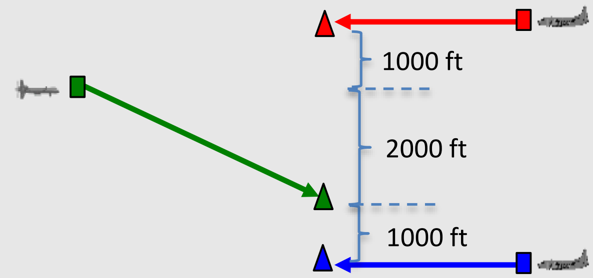
System Under Test: Radar

Display: CPDS

Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
No	YES	YES	No





Scenario(s): #182

Lateral Offset = N/A

SS Alerting Boundary = N/A

Minimum Altitude Offset ≥ 1000 ft

Intruder 1 Equipage: DGPS

Intruder 2 Equipage: DGPS

Test Objective (TO)

1. Track Radar Range and Accuracy against two intruders

Evaluation Criteria

Range and angular accuracy are within the limits defined in SC228. No track losses, track splits or false targets during the test.

Test Method

- MANEUVER: Ownship descent , Intruders fly without maneuver
- Rel. Bearing: Intruder 1 = 0<IBA<30 , Intruder 2 = 0<IBA<-30
- Progressive Closure: Ownship = 160 KGS, Intruder 1 = 160 KGS, Intruder 2 = 160 KGS
- Altitude: >10k MSL
- Encounter Length: TBD min
- Stable Conditions: TBD min before CPA
- Climb Rate: TBD ft/min
- Tolerance: TBD

Success Criteria

- Intruders are acquired at least at 8nm and from own ship and tracked until 1nm or within Radar's FOV. Intruder aircrafts should maintain heading within ±5 degrees of the required heading.

Expected Results

Intruders are acquired at greater than 12 nm and tracked until 0.5nm, results should be comparable to ADS-B
Target below the own ship will leave Radar's FOV earlier than target above ownship

Additional Information

Requirement: 16 scenarios 0<IBA<30

TEST OBJECTIVES

GA Radar Statistical Run #8

Section DAA MOPS / Version: R4, R7, R9, R11, R13-16, R22-25,R28, R29, R30, R33, R34, R35

Configuration

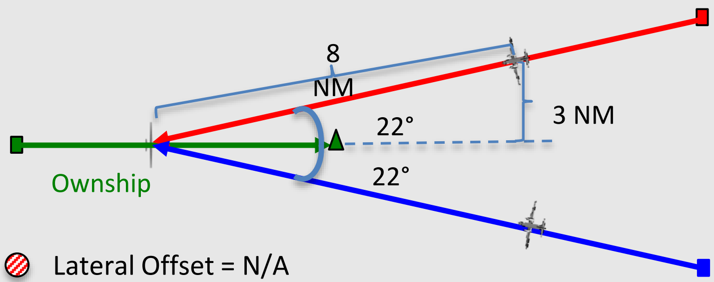
Scenario(s): #183

System Under Test: Radar

Display: CPDS

Contributing Sensors:

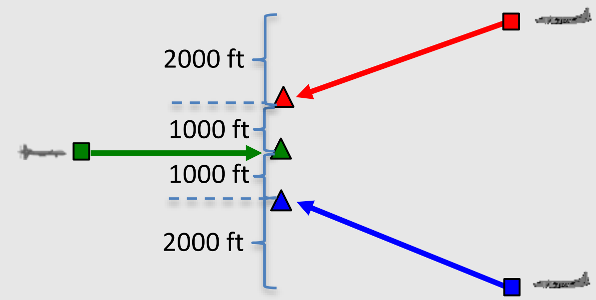
TCAS	ADS-B	Radar	Fusion
No	YES	YES	No



Lateral Offset = N/A

SS Alerting Boundary = N/A

Minimum Altitude Offset ≥ 1000 ft



Intruder 1 Equipage: DGPS

Intruder 2 Equipage: DGPS

Test Objective (TO)	1. Track Radar Range and Accuracy against two intruders
Evaluation Criteria	Range and angular accuracy are within the limits defined in SC228. No track losses, track splits or false targets during the test.
Test Method	• MANEUVER: Ownship flies without maneuver , Intruder 1 climbs , Intruder 2 descends fly without maneuver • Rel. Bearing: Intruder 1 = 0<IBA<30 , Intruder 2 = 0<IBA<-30 • Progressive Closure: Ownship = 160 KGS, Intruder 1 = 160 KGS, Intruder 2 = 160 KGS • Altitude: >10k MSL • Encounter Length: TBD min • Stable Conditions: TBD min before CPA • Climb Rate: TBD ft/min • Descent Rate: TBD ft/min • Tolerance: TBD
Success Criteria	• Intruders are acquired at least at 8nm and from own ship and tracked until 1nm. Intruder aircrafts should maintain heading within ±5 degrees of the required heading.
Expected Results	Intruders are acquired at greater than 12 nm and tracked until 0.5nm, results should be comparable to ADS-B
Additional Information	For climb/descend start 3000 ft below/above and then climb / descend by 2000 feet so final separation is 1000 feet. Descend at 1500 ft/mi, ascend at aircraft capability 1500 or less Requirement: 16 scenarios 0<IBA<30

TEST OBJECTIVES

GA Radar Statistical Run #9

Section DAA MOPS / Version: R4, R7, R9, R11, R13-16, R22-25,R28, R29, R30, R33, R34, R35

Configuration

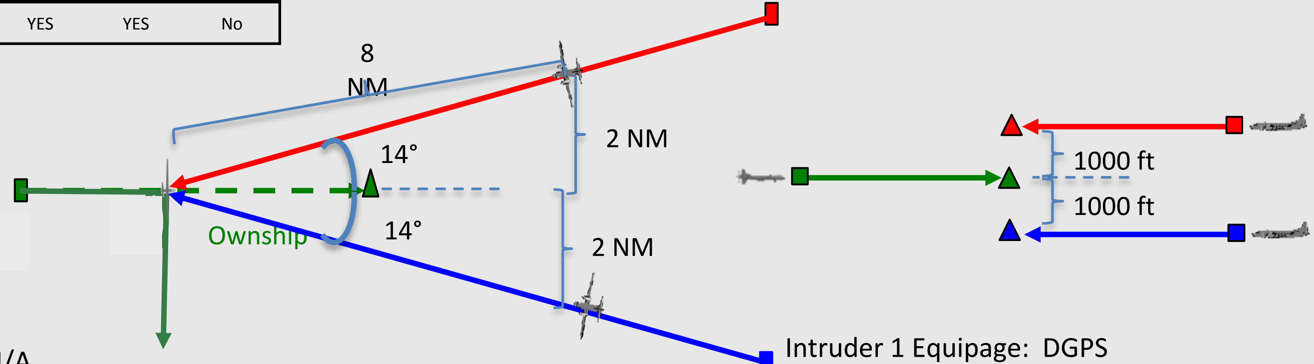
Scenario(s): #184

System Under Test: Radar

Display: CPDS

Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
No	YES	YES	No



Intruder 1 Equipage: DGPS
Intruder 2 Equipage: DGPS

Lateral Offset = N/A
SS Alerting Boundary = N/A
Minimum Altitude Offset = 1000 ft

Test Objective (TO)

1. Track Radar Range and Accuracy against two intruders

Evaluation Criteria

Range and angular accuracy are within the limits defined in SC228. No track losses, track splits or false targets during the test.

Test Method

- MANEUVER: Ownship flies horizontal maneuver , Intruders fly without maneuver
- Rel. Bearing: Intruder 1 = 0<IBA<30 , Intruder 2 = 0<IBA<-30
- Progressive Closure: Ownship = 160 KGS, Intruder 1 = 160 KGS, Intruder 2 = 160 KGS
- Altitude: >10k MSL
- Encounter Length: TBD min
- Stable Conditions: TBD min before CPA
- Tolerance: TBD

Success Criteria

- Intruders are acquired at least at 8nm and from own ship and tracked until they are outside of Radar FOV. Intruder aircrafts should maintain heading within ±5 degrees of the required heading.

Expected Results

Intruders are acquired at greater than 12 nm and tracked until the own ship turns and targets leave Radar's FOV.
Intruder 2 will remain in radar FOV longer than Intruder 1

Additional Information

90 degree turn
Requirement: 2 with ownship horizontal maneuver

TEST OBJECTIVES

GA Radar Statistical Run #10

Section DAA MOPS / Version: R4, R7, R9, R11, R13-16, R22-25,R28, R29, R30, R33, R34, R35

Configuration

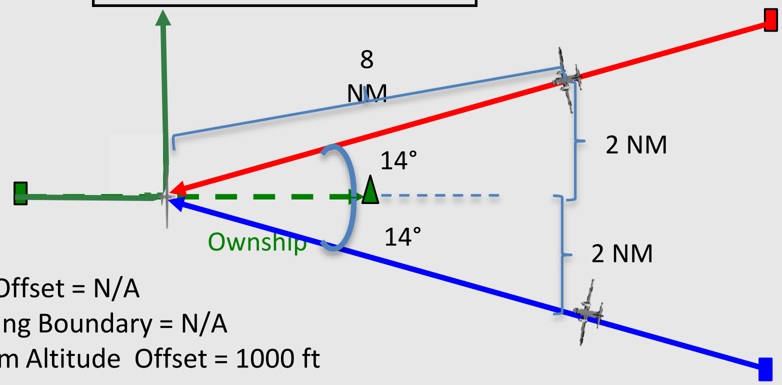
Scenario(s): #185

System Under Test: Radar

Display: CPDS

Contributing Sensors:

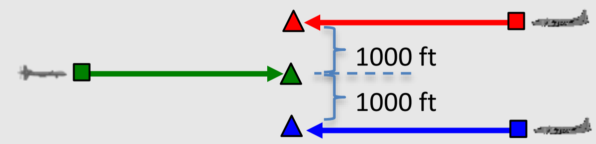
TCAS	ADS-B	Radar	Fusion
No	YES	YES	No



Lateral Offset = N/A

SS Alerting Boundary = N/A

Minimum Altitude Offset = 1000 ft



Intruder 1 Equipage: DGPS

Intruder 2 Equipage: DGPS

Test Objective (TO)

1. Track Radar Range and Accuracy against two intruders

Evaluation Criteria

Range and angular accuracy are within the limits defined in SC228. No track losses, track splits or false targets during the test.

Test Method

- MANEUVER: Ownship flies horizontal maneuver , Intruders fly without maneuver
- Rel. Bearing: Intruder 1 = 0<IBA<30 , Intruder 2 = 0<IBA<-30
- Progressive Closure: Ownship = 160 KGS, Intruder 1 = 160 KGS, Intruder 2 = 160 KGS
- Altitude: >10k MSL
- Encounter Length: TBD min
- Stable Conditions: TBD min before CPA
- Tolerance: TBD

Success Criteria

- Intruders are acquired at least at 8nm and from own ship and tracked until they are outside of Radar FOV. Intruder aircrafts should maintain heading within ±5 degrees of the required heading

Expected Results

Intruders are acquired at greater than 12 nm and tracked until the own ship turns and targets leave Radar's FOV.
Intruder 1 will remain in radar FOV longer than Intruder 2

Additional Information

90 degree turn
Requirement: 2 with ownship horizontal maneuver,

TEST OBJECTIVES

GA Radar Statistical Run #11 & #12

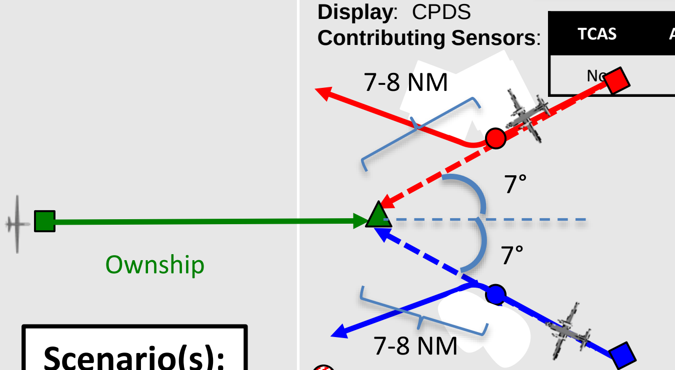
Section DAA MOPS / Version: R4, R7, R9, R11, R13-16, R22-25,R28, R29, R30, R33, R34, R35

Configuration

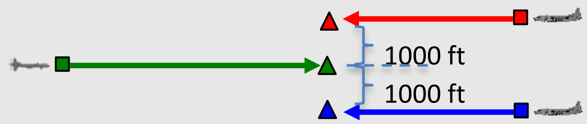
System Under Test: Radar

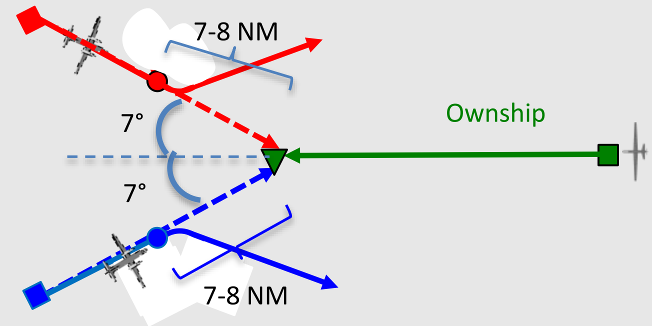
Display: CPDS
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
No	YES	YES	No



Scenario(s): #186-187





Lateral Offset = N/A
SS Alerting Boundary = N/A
Minimum Altitude Offset = 1000 ft

Intruder 1 Equipage: DGPS
Intruder 2 Equipage: DGPS

Test Objective (TO)

1. Track Radar Range and Accuracy against two intruders

Evaluation Criteria

Range and angular accuracy are within the limits defined in SC228. No track losses, track splits or false targets during the test.

Test Method

- MANEUVER: Ownship flies without maneuver, Intruders fly horizontal maneuver
- Rel. Bearing: Intruder 1 = 0<IBA<30 , Intruder 2 = 0<IBA<30
- Progressive Closure: Ownship = 160 KGS, Intruder 1 = 160 KGS, Intruder 2 = 160 KGS (Ownship and intruder speeds should be adjusted to fit profile)
- Altitude: >10k MSL
- Encounter Length: TBD min
- Stable Conditions: TBD min before CPA
- Tolerance: TBD

Success Criteria

- Intruders are acquired at least at 8nm and from own ship and tracked until 1nm or within Radar's FOV. Intruder aircrafts should maintain heading within ±5 degrees of the required heading.

Expected Results

Intruders are acquired at greater than 8 nm and tracked until the own ship turns and targets leave Radar's FOV.

Additional Information

Start head-on, then 45 degree turn at 7-8 NM. SV: I'm still a little confused on what the difference is between these two. Different relative bearing? Perhaps one can be performed at 0 and the other at 30?
Requirement: 2 with intruder horizontal maneuver

TEST OBJECTIVES

GA Radar **Statistical** Run #13-17	**Section DAA MOPS / Version: R4, R7, R9, R11, R13-16, R22-25,R28, R29, R30, R33, R34, R35**

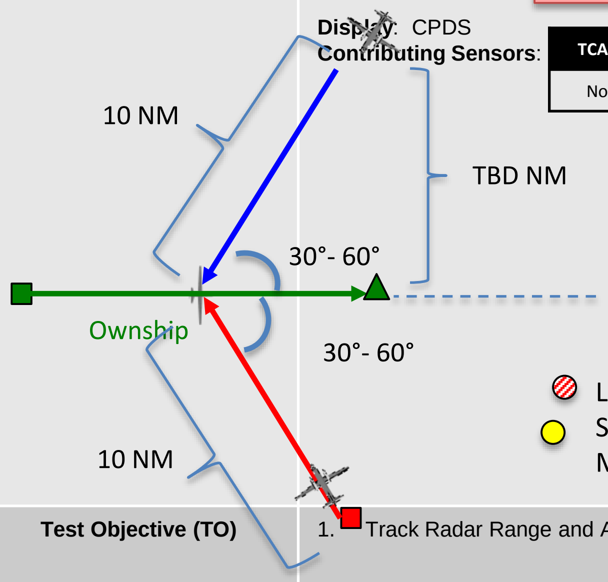
Configuration

System Under Test: Radar

Display: CPDS

Contributing Sensors:

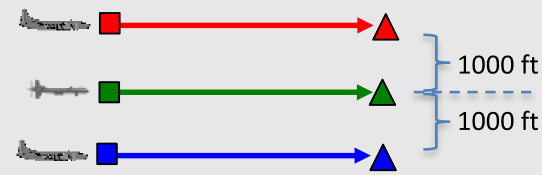
TCAS	ADS-B	Radar	Fusion
No	YES	YES	No



Lateral Offset = N/A

SS Alerting Boundary = N/A

Minimum Altitude Offset = 1000 ft



Intruder 1 Equipage: DGPS

Intruder 2 Equipage: DGPS

Test Objective (TO)

1. Track Radar Range and Accuracy against two intruders

Evaluation Criteria

Range and angular accuracy are within the limits defined in SC228. No track losses, track splits or false targets during the test.

Test Method

Scenario(s): #188-192

- MANEUVER: Ownship and Intruders fly without maneuver
- Rel. Bearing: Intruder 1 = 30<IBA<60 , Intruder 2 = -30<IBA<-60
- Progressive Closure: Ownship = 160 KGS, Intruder 1 = 160 KGS, Intruder 2 = 160 KGS (Ownship and intruder speeds should be adjusted to fit profile)
- Altitude: >10k MSL
- Encounter Length: TBD min
- Stable Conditions: TBD min before CPA
- Tolerance: TBD

Success Criteria

- Intruders are acquired at least at 6.5 nm and from own ship and tracked until 1nm or within Radar's FOV. Intruder aircrafts should maintain heading within ±5 degrees of the required heading.

Expected Results

Intruders are acquired at greater than 8nm and tracked until the own ship turns and targets leave Radar's FOV.

Additional Information

Requirement: 10 scenarios 30<IBA<60

TEST OBJECTIVES

GA Radar **Statistical** Run #18-19	Section DAA MOPS / Version: R4, R7, R9, R11, R13-16, R22-25,R28, R29, R30, R33, R34, R35

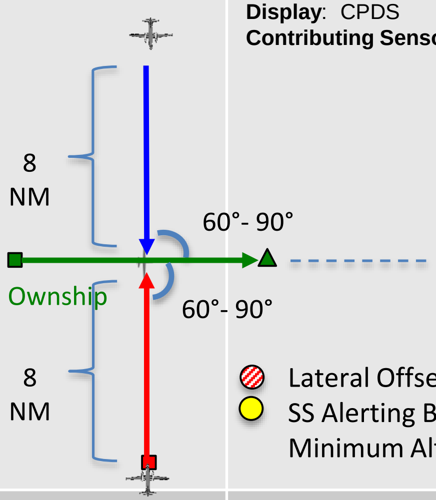
Configuration

System Under Test: Radar

Display: CPDS

Contributing Sensors:

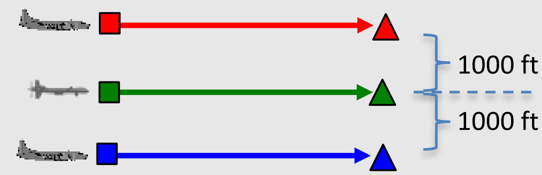
TCAS	ADS-B	Radar	Fusion
No	YES	YES	No



Lateral Offset = N/A

SS Alerting Boundary = N/A

Minimum Altitude Offset = 1000 ft



Intruder 1 Equipage: DGPS

Intruder 2 Equipage: DGPS

Test Objective (TO)	1. Track Radar Range and Accuracy against two intruders
Evaluation Criteria	Range and angular accuracy are within the limits defined in SC228. No track losses, track splits or false targets during the test.
Test Method **Scenario(s): #193-194**	• MANEUVER: Ownship and Intruders fly without maneuver • Rel. Bearing: Intruder 1 = 60<IBA<90 , Intruder 2 = -60<IBA<-90 • Progressive Closure: Ownship = 160 KGS, Intruder 1 = 160 KGS, Intruder 2 = 160 KGS (Ownship and intruder speeds should be adjusted to fit profile) • Altitude: >10k MSL • Encounter Length: TBD min • Stable Conditions: TBD min before CPA • Tolerance: TBD
Success Criteria	• Intruders are acquired at least at 6nm and from own ship and tracked until 1nm or within Radar's FOV. Intruder aircrafts should maintain heading within ±5 degrees of the required heading.
Expected Results	Intruders are acquired at least at 7nm and from own ship and tracked until 1nm or within Radar's FOV. Intruder aircrafts should maintain heading within ±5 degrees of the required heading.
Additional Information	Maintain bearing angle of 75 deg to intruder, intruder speed should be (1/sin 75=1.035) that of ownship to maintain Requirement: 4 scenarios 60<IBA<90

TEST OBJECTIVES

GA Radar Statistical Run #20	Section DAA MOPS / Version: R4, R7, R9, R11, R13-16, R22-25,R28, R29, R30, R33, R34, R35

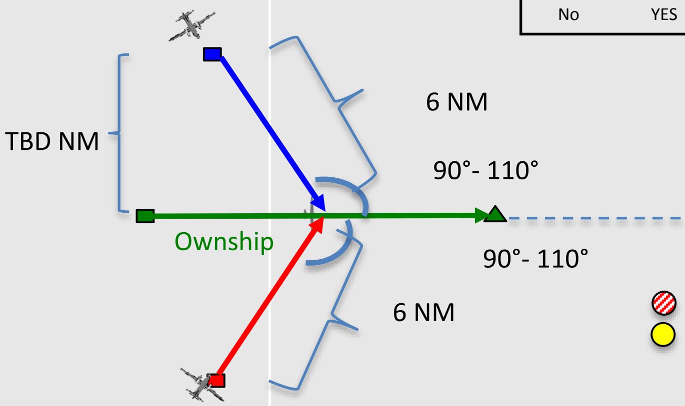
Configuration

System Under Test: Radar

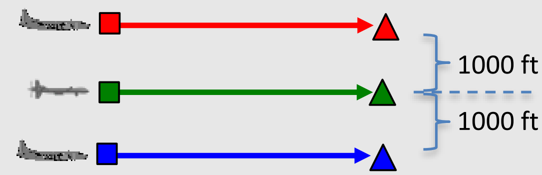
Display: CPDS

Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
No	YES	YES	No



Lateral Offset = N/A
SS Alerting Boundary = N/A
Minimum Altitude Offset = 1000 ft



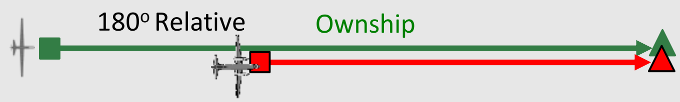
Intruder 1 Equipage: DGPS
Intruder 2 Equipage: DGPS

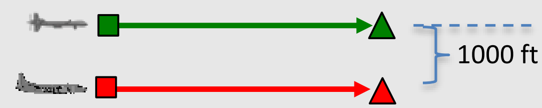
Test Objective (TO)	1. Track Radar Range and Accuracy against two intruders
Evaluation Criteria	Range and angular accuracy are within the limits defined in SC228. No track losses, track splits or false targets during the test.
Test Method **Scenario(s): #195**	• MANEUVER: Ownship and Intruders fly without maneuver • Rel. Bearing: Intruder 1 = 90<IBA<110 , Intruder 2 = 90<IBA<110 • Progressive Closure: Ownship = 160 KGS, Intruder 1 = 160 KGS, Intruder 2 = 160 KGS (Ownship and intruder speeds should be adjusted to fit profile) • Altitude: >10k MSL • Encounter Length: TBD min • Stable Conditions: TBD min before CPA • Tolerance: TBD
Success Criteria	• Intruders are acquired at least at 4nm and from own ship and tracked until 1nm or within Radar's FOV. Intruder aircrafts should maintain heading within $\pm$5 degrees of the required heading.
Expected Results	Intruders are acquired at greater than 5 nm and tracked until the own ship turns and targets leave Radar's FOV.
Additional Information	Repeat of FT3 flight but starting at longer range, intruder speed should be (1/sin 80=1.015) that of intruder to maintain Requirement: 2 scenarios 90<IBA<110

TEST OBJECTIVES

GA Radar **Non Statistical** **Run #21**	**Section DAA MOPS / Version: R2**
Configuration	**System Under Test**: Radar **Display**: CPDS **Contributing Sensors**:

TCAS	ADS-B	Radar	Fusion
No	YES	YES	No





Scenario(s): #196

Lateral Offset = N/A
SS Alerting Boundary = N/A
Minimum Altitude Offset = 1000 ft

Intruder 1 Equipage: DGPS
Intruder 2 Equipage: DGPS

Test Objective (TO)	1. Track Radar Range and Accuracy against two intruders
Evaluation Criteria	Range and angular accuracy are within the limits defined in SC228. No track losses, track splits or false targets during the test.
Test Method	• MANEUVER: Ownship and Intruder fly without maneuver • Rel. Bearing: Intruder 1 = 180 degrees • Progressive Closure: Ownship = 160 KGS, Intruder 1 = 160 KGS **(OWNSHIP to be faster at least by 50KGS)** • Altitude: >10k MSL • Encounter Length: TBD min • Stable Conditions: TBD min before CPA • Tolerance: TBD
Success Criteria	• Intruders are acquired at least at 4nm and from own ship and tracked until Own ship overtakes the intruder. Intruder aircrafts should maintain heading within $\pm$5 degrees of the required heading.
Expected Results	Intruders are acquired at greater than 5 nm and tracked until the own ship turns and targets leave Radar's FOV
Additional Information	Requirement: 1 with ownship overtake intruder (above)

TEST OBJECTIVES

GA Radar **Non Statistical** Run #23-32	**Section DAA MOPS / Version: Section 2.2.6.r**

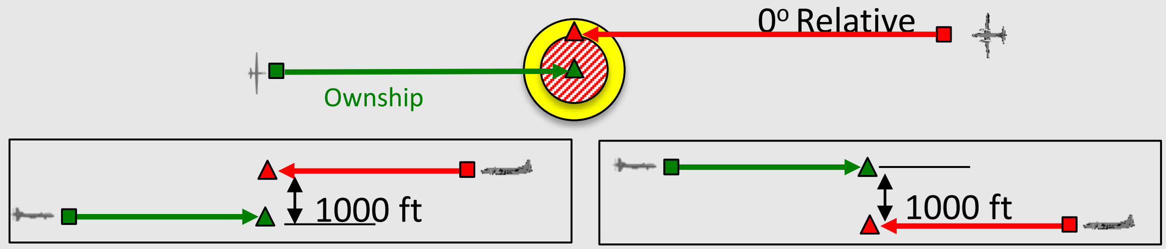
Configuration

System Under Test: Radar

Display: CPDS

Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
No	YES	YES	No



Lateral Offset = 0.5 nmi
SS Alerting Boundary = 0.75 nmi
Minimum Altitude Offset = 1000 ft

Intruder 1 Equipage: DGPS
Intruder 2 Equipage: DGPS

Scenario(s): #198-207

Test Objective (TO)

1. #23 – 1k AGL	6. #28 – 1k AGL
2. #24 – 2k AGL	7. #29 – 2k AGL
3. #25 – 3k AGL	8. #30 – 3k AGL
4. #26 – 4k AGL	9. #31 – 4k AGL
5. #27 – 5k AGL	10. #32 – 5k AGL

Evaluation Criteria

Range and angular accuracy are within the limits defined in SC228. No track losses, track splits or false targets during the test.

Test Method

- MANEUVER: Ownship and Intruder fly without maneuver
- Rel. Bearing: Intruder 1 = 0 degrees
- Progressive Closure: Ownship = 150 KGS, Intruder 1 = 180 KGS
- Altitude: 1,000 – 5,000 AGL
- Encounter Length: TBD min
- Stable Conditions: TBD min before CPA
- Tolerance: TBD

Success Criteria

- Intruders are acquired at least at 8nm and from own ship and tracked until 1nm or within Radar's FOV.
- Some fast ground Moving Targets, could be acquired. Intruder aircrafts should maintain heading within ± 5 degrees of the required heading.

Expected Results

- Intruders are acquired at least at 8nm and from own ship and tracked until 1nm or within Radar's FOV.
- Some fast ground Moving Targets, could be acquired. Intruder aircrafts should maintain heading within ± 5 degrees of the required heading.

Additional Information

Requirement: Low altitude

TEST OBJECTIVES

GA Radar **Non Statistical** **Run #33-34**

Section DAA MOPS / Version: R6

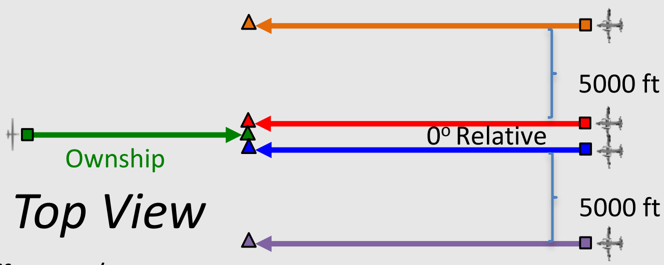
Configuration

System Under Test: Radar

Display: CPDS

Contributing Sensors:

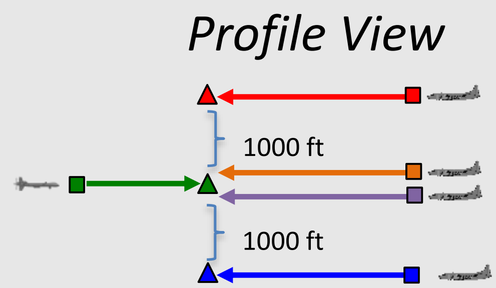
TCAS	ADS-B	Radar	Fusion
No	YES	YES	No



Lateral Offset = N/A

SS Alerting Boundary = N/A

Minimum Altitude Offset = 1000 ft



Intruder 1 Equipage: DGPS

Intruder 2 Equipage: DGPS

Scenario(s): #208-209

Test Objective (TO)

Evaluation Criteria

Range and angular accuracy are within the limits defined in SC228. No track losses, track splits or false targets during the test.

Test Method

- MANEUVER: Ownship and Intruders fly without maneuver
- Rel. Bearing: 0 degrees
- Progressive Closure: Ownship = Various, Intruder 1(High Speed), Intruder 2 = Various, (Medium Speed) Intruder 3 = Various, (medium Speed) = Various, Intruder 4 = Low Speed
- Altitude: >10k MSL
- Encounter Length: TBD min
- Stable Conditions: TBD min before CPA
- Tolerance: TBD

Success Criteria

- All four Intruders are acquired at least at 8nm (depending on RCS) and from own ship and tracked until 1nm or within Radar's FOV. Intruder aircrafts should maintain heading within $\pm$5 degrees of the required heading. System should track all the four intruders simultaneously.

Expected Results

- All four Intruders are acquired at least at 10 nm (depending on RCS) and from own ship and tracked until 1nm or within Radar's FOV. Intruder aircrafts should maintain heading within $\pm$5 degrees of the required heading. System should track all the four intruders simultaneously.

Additional Information

All head on, +1k vertical, -1k vertical, +5k lateral, -5k lateral

Requirement: Multiple intruders

TEST OBJECTIVES

GA Radar Non Statistical Run #35-36 | **Section DAA MOPS / Version: R30**

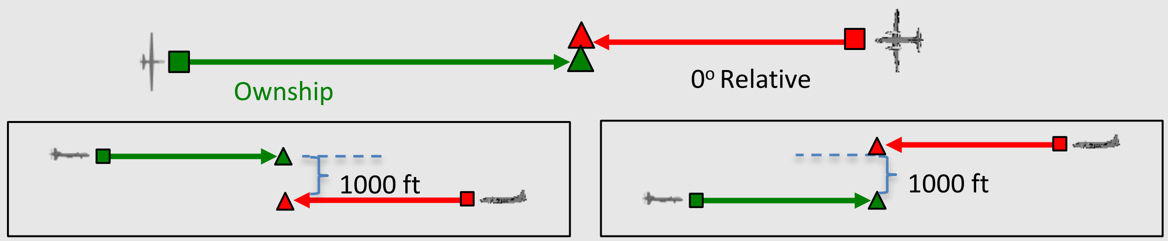
Configuration

System Under Test: Radar

Display: CPDS

Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
No	YES	YES	No



Scenario(s): #210-211

Lateral Offset = N/A

SS Alerting Boundary = N/A

Minimum Altitude Offset = 1000 ft

Intruder 1 Equipage: DGPS

Intruder 2 Equipage: DGPS

Test Objective (TO)

Evaluation Criteria

Range and angular accuracy are within the limits defined in SC228. No track losses, track splits or false targets during the test.

Test Method

- MANEUVER: Ownship and Intruders fly without maneuver
- Rel. Bearing: Intruder 1 = 0 degrees
- Progressive Closure: Ownship = 150 KGS, Intruder 1 = 100 KGS
- Altitude: <10k MSL
- Encounter Length: TBD min
- Stable Conditions: TBD min before CPA
- Tolerance: TBD

Success Criteria

- Intruders are acquired at least at 5nm and from own ship and tracked until 1nm or within Radar's FOV. Intruder aircrafts should maintain heading within ±5 degrees of the required heading.

Expected Results

Intruders are acquired at greater than 5 nm and tracked until the own ship turns and targets leave Radar's FOV.

Additional Information

Basic head on scenarios

Requirement: Other intruders (Glider)

National Aeronautics and Space Administration

UAS in the NAS
FT4 Test Objectives
TCAS

TCAS Encounters traceback

- **TCAS Encounters based on AC 20-151B, Chapter 3**
- **MOPS traced back to**
  - RTCA DO-185B MOPS for TCAS II
  - RTCA DO-300B MOPS for TCAS II
  - RTCA DO-317B MOPS for ASA System
  - TSO-119d

TCAS RAs enabled in 1107.4 DAA software

Demonstrated in GA-ASI 1107.4 flight test

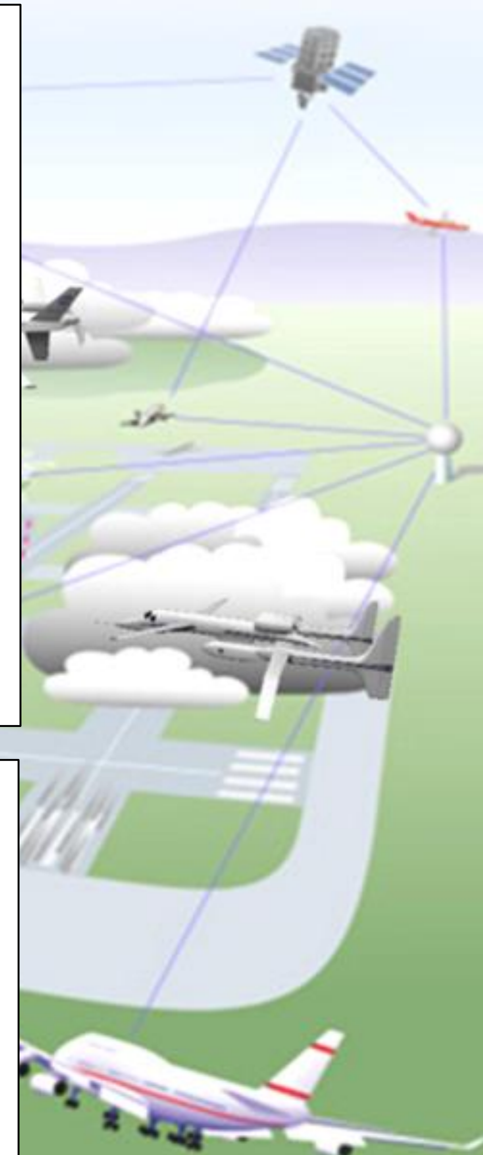
Not demonstrated in GA-ASI 1107.4 flight test

CORRECTIVE RESOLUTION ADVISORY

1. CLIMB 1500 FPM
2. DESCEND -1500 FPM
3. CROSSING CLIMB 1500 FPM
4. CROSSING DESCEND -1500 FPM
5. LEVEL OFF (REDUCED CLIMB)
6. LEVEL OFF (REDUCED DESCEND)
7. REVERSE CLIMB 1500 FPM
8. REVERSE DESCENT -1500 FPM
9. INCREASED CLIMB 2500 FPM
10. INCREASED DESCENT -2500 FPM*
11. MAINTAIN VERTICAL SPEED (CLIMBING)
12. MAINTAIN VERTICAL SPEED (DESCENDING)
13. MULTI-THREAT (CLIMBING)
14. MULTI-THREAT (DESCENDING)
15. LEVEL OFF (WEAKENING RA)
16. CLEAR OF CONFLICT

PREVENTIVE RESOLUTION ADVISORY

1. MONITOR VERTICAL SPEED (DO NOT CLIMB)
2. MONITOR VERTICAL SPEED (DO NOT CLIMB >500 FPM)
3. MONITOR VERTICAL SPEED (DO NOT CLIMB >1000 FPM)
4. MONITOR VERTICAL SPEED (DO NOT CLIMB >2000 FPM)
5. MONITOR VERTICAL SPEED (DO NOT DESCEND)
6. MONITOR VERTICAL SPEED (DO NOT DESCEND >500 FPM)
7. MONITOR VERTICAL SPEED (DO NOT DESCEND >1000 FPM)
8. MONITOR VERTICAL SPEED (DO NOT DESCEND >2000 FPM)
9. MONITOR VERTICAL SPEED (DO NOT DESCEND AND DO NOT CLIMB)



TEST OBJECTIVES – TCAS Shadow

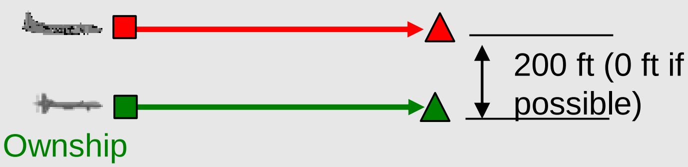
Demonstrate TCAS RF Shadow boundary | **TBD**

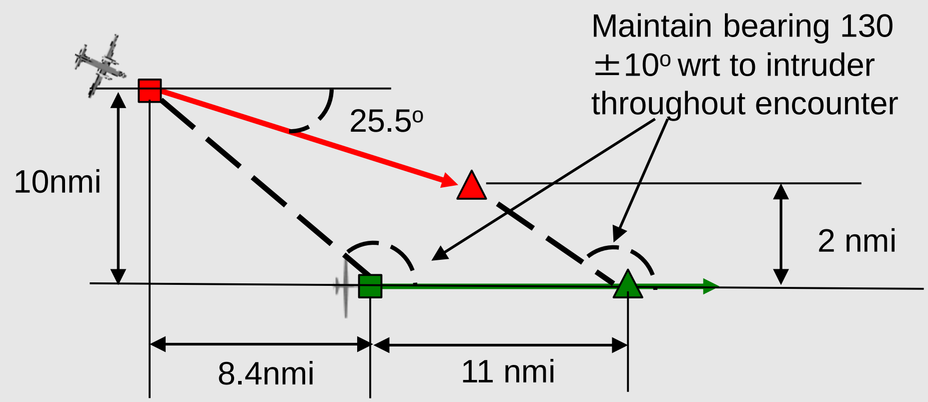
Configuration

System Under Test: Any

Display: TCAS on HUD
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	No	No





Scenario(s): #212

- Lateral Offset = 0.5 NM
- SS Alerting Boundary = N/A NM
- Minimum Altitude Offset ≥ 200 ft

Test Objective (TO)	1. Identify RF shadow region of TCAS directional antenna (from V-tail, fuselage)
Evaluation Criteria	N/A
Test Method	• MANEUVER – *NO* • MANEUVER –*Fly commanded heading* • Start at 120 knots TAS for ownship and 220 TAS for intruder • Encounter Length: 5.5 min • Stable Conditions: Maintain 130 +/- 10 degree bearing • Climb Rate: • Roll Rate: • Pitch Rate: • Tolerance: ± 5 sec, adjust speed to maintain bearing range
Success Criteria	• Identify TCAS RF shadow range when V-tail is blocking line of sight with intruder aircraft
Expected Results	Intruder TCAS signal to appear as range closes between intruder and ownship
Additional Information	Prefer to repeat with altitude offset 0 ft, -200 ft and -400 ft)

TEST OBJECTIVES – TCAS Increasing Climb

Demonstrate TCAS Corrective RA# 9 (INCREASED CLIMB)

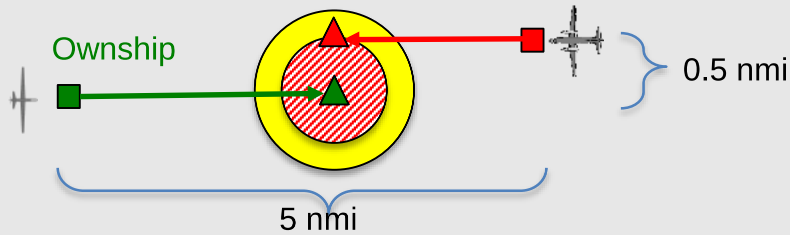
TBD

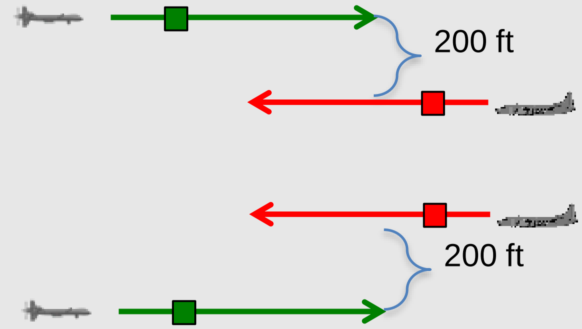
Configuration

System Under Test: Any

Display: TCAS on HUD
Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	No	No





Lateral Offset = 0.5 NM
SS Alerting Boundary = N/A NM
Minimum Altitude Offset ≥ 150 ft

Scenario(s): #215/216

Test Objective (TO)

1. Demonstrate strengthening climb RA from TCAS

Evaluation Criteria

- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA1, CA2
- TO-2 TCAS issues a strengthening climb RA

Test Method

- MANEUVER – *Advisory only*
- MANEUVER –*Fly commanded heading*
- 130 IAS for ownship, 150 TAS for intruder
- Encounter Length: 2 min
- Stable Conditions: stable heading at IP
- Climb Rate: N/A
- Roll Rate: 0
- Pitch Rate: 0
- Tolerance: speed is not a large factor, importance in vertical and horizontal CPA distance

Success Criteria

- Same as Evaluation Criteria

Expected Results

[3nmi distance between ownship/intruder]: Climb RA Triggered
[1.2 nmi distance between ownship/intruder]: Increased Climb RA triggered
End of Scenario as soon as Increased Climb RA triggered, break away

Additional Information

Need acceptance whether 150 ft vertical separation / 1 nmi horizontal separation is acceptable

TEST OBJECTIVES – TCAS Head on Multi-threat Climbing

Demonstrate TCAS Corrective RA# 13 (MULTI-THREAT: Climb)	TBD

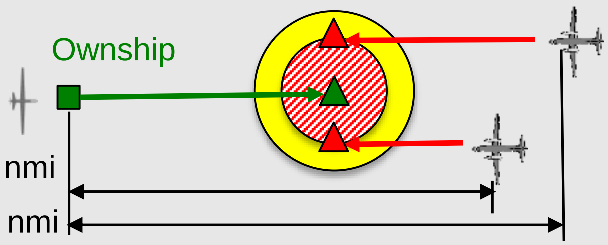
Configuration

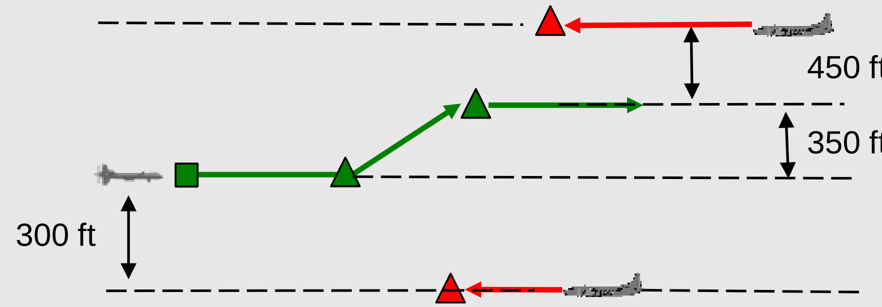
System Under Test: Any

Display: TCAS on HUD

Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	No	No





Lateral Offset = 0.4 NM
SS Alerting Boundary = N/A NM
Minimum Altitude Offset ≥ 300 ft

Scenario(s): #217/218

Test Objective (TO)

1. Demonstrate multi-threat RA during descend

Evaluation Criteria

- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA1, CA2
- TO-2 TCAS issues a climb RA
- TO-3 TCAS issues a Multi-threat RA during descend to level-off

Test Method

- MANEUVER – *Advisory then Auto*
- MANEUVER –*Fly commanded heading*
- Ownship: 130 IAS, Intruders: 130 TAS
- Encounter Length: 5 min
- Stable Conditions: steady level flight and velocity at entry point
- Climb Rate: Ownship (+1500 FPM)
- Tolerance: distance is flexible, but intruder should be 3 nmi horizontally away from each other

Success Criteria

- Same as Evaluation Criteria

Expected Results

1. TCAS issues a climb RA
2. TCAS issues a leve-off RA
3. TCAS issues a level-off RA (multiship)

Additional Information

Validated in SIL

TEST OBJECTIVES – TCAS Head on Multi-threat descending

Demonstrate TCAS Corrective RA# 13 (MULTI-THREAT: Descend)	TBD

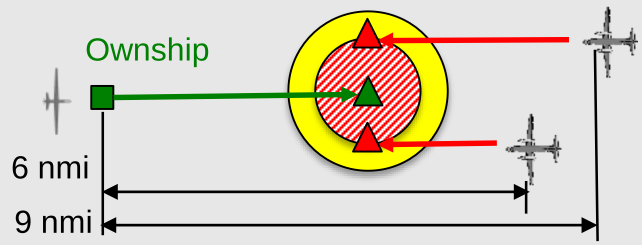
Configuration

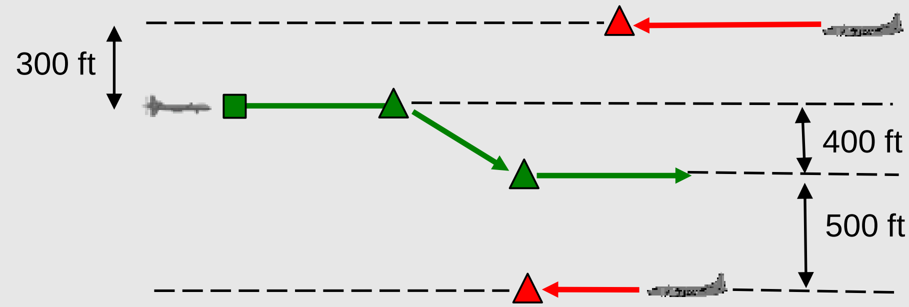
System Under Test: Any

Display: TCAS on HUD

Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	No	No





Lateral Offset = 0.4 NM
SS Alerting Boundary = N/A NM
Minimum Altitude Offset ≥ 300 ft

Scenario(s): #219/220

Test Objective (TO)

1. Demonstrate multi-threat RA during descend

Evaluation Criteria

- TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA1, CA2
- TO-2 TCAS issues a descent RA
- TO-3 TCAS issues a Multi-threat RA during descend to level-off

Test Method

- MANEUVER – *Advisory then Auto*
- MANEUVER –*Fly commanded heading*
- Ownship: 130 IAS, Intruders: 130 TAS
- Encounter Length: 5 min
- Stable Conditions: steady level flight and velocity at entry point
- Climb Rate: Ownship (-1500 FPM)
- Tolerance: distance is flexible, but intruder should be 3 nmi horizontally away from each other

Success Criteria

- Same as Evaluation Criteria

Expected Results

1. TCAS issues a descent RA
2. TCAS issues a leve-off RA
3. TCAS issues a level-off RA (multiship)

Additional Information

Validated in SIL

TEST OBJECTIVES – TCAS Head on Do not Descend (>-500 FPM)

Demonstrate TCAS Corrective RA# 13 (MULTI-THREAT: Descend)	TBD

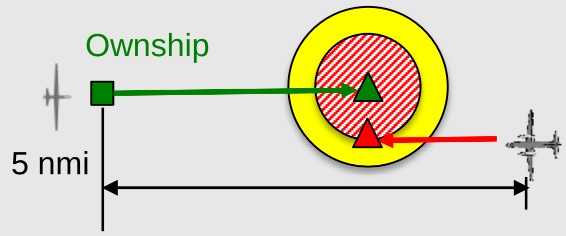
Configuration

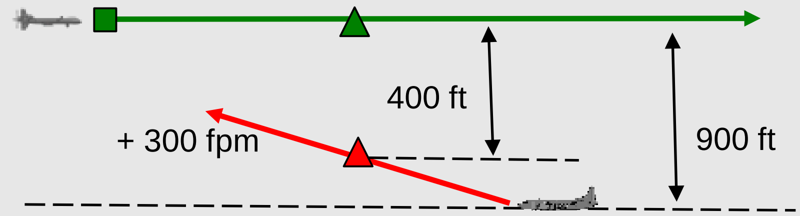
System Under Test: Any

Display: TCAS on HUD

Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	No	No





Scenario(s): #221/222

Lateral Offset = 0.4 NM

SS Alerting Boundary = N/A NM

Minimum Altitude Offset ≥ 300 ft

Test Objective (TO)	1. Demonstrate multi-threat RA during descend
Evaluation Criteria	• TO-1 Alerting shall progress from NO FACTOR, Proximate, SS, CA1, CA2 • TO-2 TCAS issues a descent RA • TO-3 TCAS issues a Multi-threat RA during descend to level-off
Test Method	• MANEUVER – *Advisory only* • Ownship: 120 IAS, Intruders: 130 TAS • Encounter Length: 5 min • Stable Conditions: steady level flight and velocity at entry point • Climb Rate: None
Success Criteria	• Same as Evaluation Criteria
Expected Results	1. TCAS issues a Do not descend >-500 FPM RA + Additional encounter >-1500 FPM RA
Additional Information	Validated in SIL, need to extract SAAP data for horizontal and vertical CPA

National Aeronautics and Space Administration

UAS in the NAS
FT4 Test Objectives
(HON Tracker Scenarios)

TEST OBJECTIVES – Vertical Rate Estimation

Demonstrate performance in an overtaking scenario.	Section ### DAA MOPS / Version: July 28, 2015

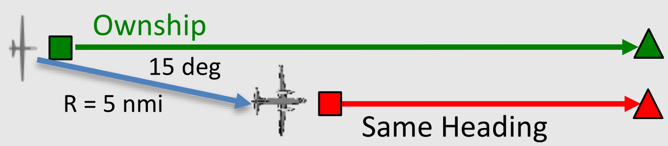
Configuration

System Under Test: GA-CPDS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*

Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	Yes	YES



Scenario(s): #223-226

Lateral Offset = 0.5 NM

SS Alerting Boundary = 0.75 NM

Minimum Altitude Offset ≥ 400 ft

Test Objective (TO)	1. Test Vertical Rate Estimation for various vertical rates 2. SAA fusion processor correctly correlates TCAS and ADS-B & Radar tracks
Evaluation Criteria	Does the state estimate for vertical rate match the planned vertical rates of {+/- 500 ft/min, +/- 1000 ft/min; +/- 1500 ft/min; +/- 2000 ft/min}
Test Method	• 160 KIAS • Vertical Rate Doublet → climb rate for 30 sec; descend for 60 sec; climb for 30 sec. • Encounter Length: as space allows. If can only fit one doublet in, then 3 min, else 3 min * number of vertical rate doublets • Stable Conditions: 3 min before CPA • Climb Rate: {+/- 500 ft/min, +/- 1000 ft/min; +/- 1500 ft/min; +/- 2000 ft/min} • Roll Rate: 0 • Pitch Rate: 0 • Tolerance: ± 10 sec • 4 doublets at the different altitude rates
Success Criteria	• Doublets completed with expected rates • Data {sensor & track} collected in SAAP onboard Ikhana • Data collected at the LVC (Time Synced)
Expected Results	Vertical Rates match
Additional Information	

TEST OBJECTIVES – Horizontal maneuvers by both intruder and ownship aircraft simultaneously

Demonstrate performance in an overtaking scenario.	Section ### DAA MOPS / Version: July 28, 2015

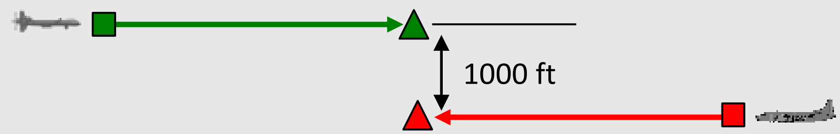
Configuration

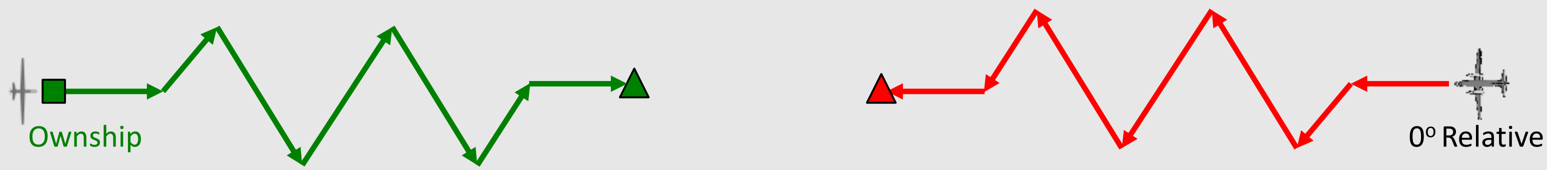
System Under Test: GA-CPDS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*

Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	Yes	YES





Scenario(s): #227-229

Test Objective (TO)	1. Tracking of an accelerating intruder 2. SAA fusion processor correctly correlates TCAS and ADS-B & Radar tracks
Evaluation Criteria	Successful data collection with successful maneuvers
Test Method	• 160 KIAS • (pull from FT3 test cards) • Standard turn rates (3 deg/sec) • Roll Rate: 0 • Pitch Rate: 0 • Tolerance: ± 10 sec • 3 scenarios
Success Criteria	• Data {sensor & track} collected in SAAP onboard Ikhana • Data collected at the LVC (Time Synced)
Expected Results	Tracking during an accelerating encounter
Additional Information	

TEST OBJECTIVES – Multi-Dimensional Intruder Maneuver

Demonstrate performance in an overtaking scenario.	Section ### DAA MOPS / Version: July 28, 2015

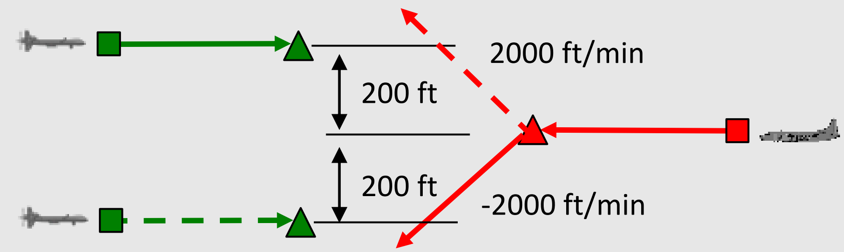
Configuration

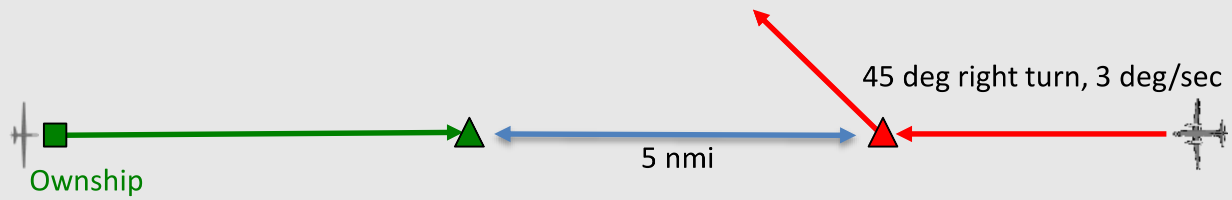
System Under Test: GA-CPDS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*

Contributing Sensors:

TCAS	ADS-B	Radar	Fusion
YES	YES	Yes	YES



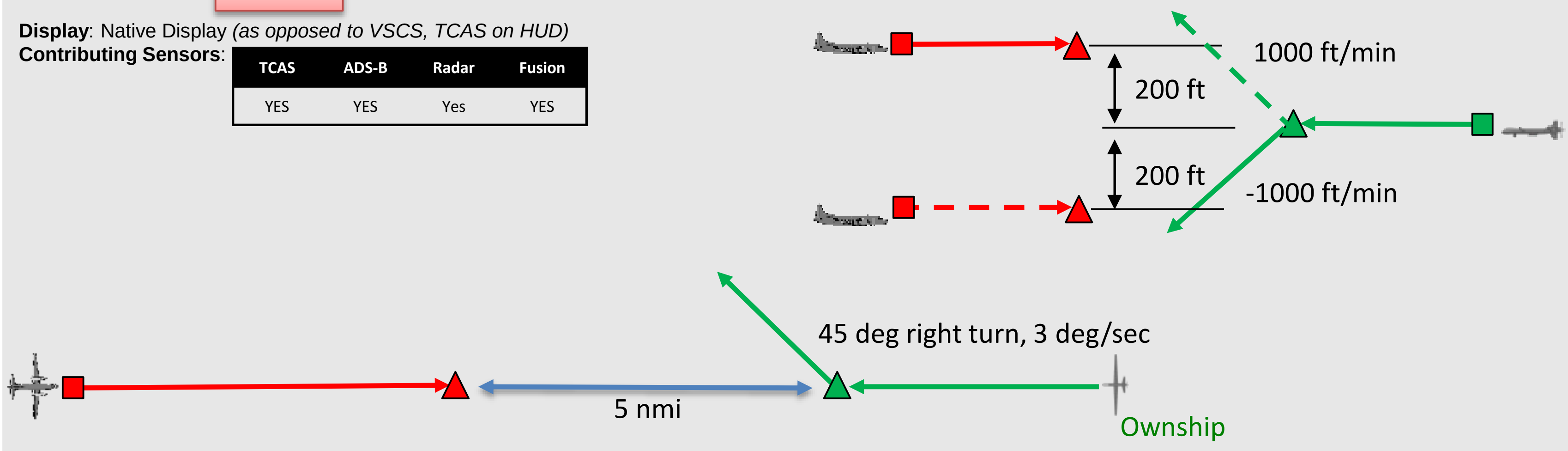


Scenario(s): #230-233

Test Objective (TO)	1. Tracking of an intruder that is performing maneuvers in multiple dimensions 2. SAA fusion processor correctly correlates TCAS and ADS-B & Radar tracks
Evaluation Criteria	Successful data collection with successful maneuvers
Test Method	• 160 KIAS • Standard turn rates (3 deg/sec) • Climb rate of +/- 2000 ft/min • Roll Rate: • Pitch Rate: • Tolerance: ± 10 sec • 2 scenarios minimally, 4 ideally
Success Criteria	• Data {sensor & track} collected in SAAP onboard Ikhana • Data collected at the LVC (Time Synced)
Expected Results	Tracking during an accelerating encounter
Additional Information	

TEST OBJECTIVES – Multi-Dimensional Ownship Maneuver	
Demonstrate performance in an overtaking scenario.	**Section ### DAA MOPS / Version: July 28, 2015**
Configuration **Scenario(s): #234-237**	**System Under Test**: GA-CPDS **Display**: Native Display *(as opposed to VSCS, TCAS on HUD)* **Contributing Sensors**:

TCAS	ADS-B	Radar	Fusion
YES	YES	Yes	YES



Test Objective (TO)	1. Tracking of an intruder while ownship is performing maneuvers in multiple dimensions 2. SAA fusion processor correctly correlates TCAS and ADS-B & Radar tracks
Evaluation Criteria	Successful data collection with successful maneuvers
Test Method	• 160 KIAS • Standard turn rates (3 deg/sec) • Climb rate of +/- 1000 ft/min • Roll Rate: • Pitch Rate: • Tolerance: ± 10 sec • 2 scenarios minimally, 4 ideally
Success Criteria	• Data {sensor & track} collected in SAAP onboard Ikhana • Data collected at the LVC (Time Synced)
Expected Results	Tracking during an accelerating encounter
Additional Information	

TEST OBJECTIVES – Vertical maneuver by one aircraft while the other aircraft is performing an horizontal maneuver

Demonstrate performance in an overtaking scenario.	Section ### DAA MOPS / Version: July 28, 2015

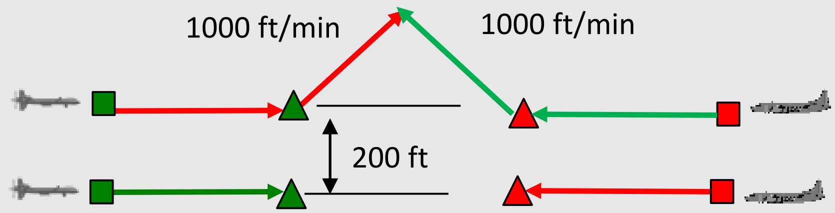
Configuration

System Under Test: GA-CPDS

Display: Native Display *(as opposed to VSCS, TCAS on HUD)*

Contributing Sensors:

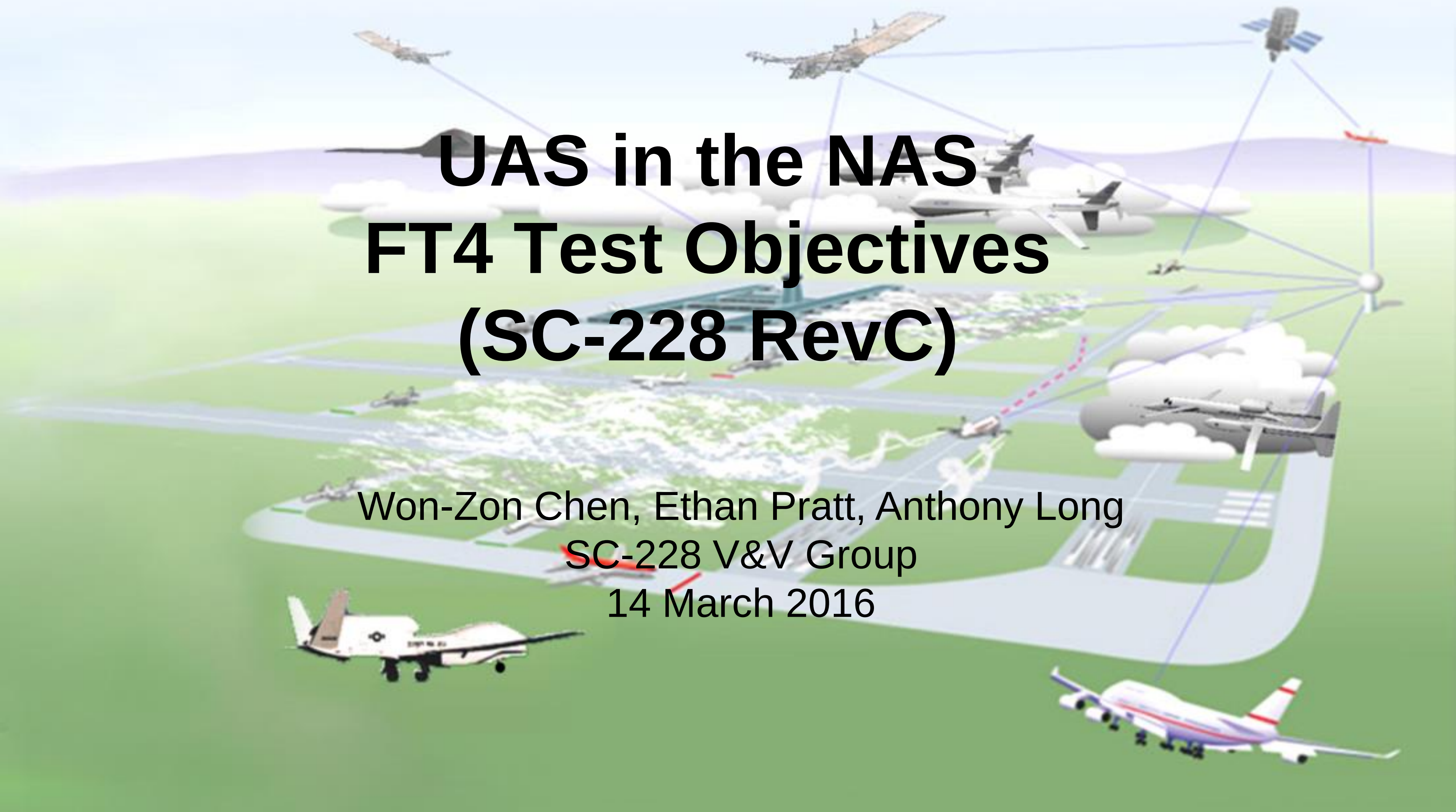
TCAS	ADS-B	Radar	Fusion
YES	YES	Yes	YES



Scenario(s): #238-241

Test Objective (TO)	1. Tracking of an intruder that is performing maneuvers in multiple dimensions 2. SAA fusion processor correctly correlates TCAS and ADS-B & Radar tracks
Evaluation Criteria	Successful data collection with successful maneuvers
Test Method	• 160 KIAS • Standard turn rates (3 deg/sec) • Climb rate of +/- 1000 ft/min • Rerun with intruder and ownship changing roles. • Roll Rate: • Pitch Rate: • Tolerance: ± 10 sec • 2 scenarios minimally, 4 ideally
Success Criteria	• Data {sensor & track} collected in SAAP onboard Ikhana • Data collected at the LVC (Time Synced)
Expected Results	Tracking during an accelerating encounter
Additional Information	

National Aeronautics and Space Administration



UAS in the NAS FT4 Test Objectives (SC-228 RevC)

Won-Zon Chen, Ethan Pratt, Anthony Long

SC-228 V&V Group

14 March 2016

SC228 FT4 Test Objectives

1. Collect overall DAA system and subsystems performance and interface data to validate DAA MOPS requirements.
   a) Sec 2.2.2 DAA architecture and interface requirements
   b) Sec 2.2.3 DAA surveillance equipment, data processing, and tracking requirements
   c) Sec 2.2.4 DAA guidance requirements
   d) Sec 2.2.5 and 2.2.6 DAA display and pilot entry subsystem requirements
   e) Assumptions described in Appendices

2. Collect radar system performance and interface data to validate Radar MOPS requirements.

3. Collect data to validate simulation models used for MOPS validation.

FT4 Test Scenario Selection Process

Development Approach and Status

- 24 test configurations were identified based on test objectives in consideration of available DAA sensors and algorithms and operational constraints.
- A comprehensive set of 35 encounter geometries were identified including some described in OSED.
- Draft test scenarios have been coordinated with NASA OWG to better align with available test assets.
- Draft test scenarios have been compared with scenarios requested by other FT4 participants to remove duplicates.
- Draft test scenarios have been prioritized and reduced to a final set of 51 scenarios which meets the constraint of available flight time.

- We will continue participating in NASA FT4 planning process to refine the final set of scenarios for flight test card preparation.

Summary of Test Configurations

Conf. #	Ownship						Intruder					Notes
	TCAS II	Tracker	Guidance	Display	Pilot	ATC	RCS Size	No Xpdr or Mode	Mode C	1090 ADS-B	TCAS II	
A	TA/RA	On	JADEM	Standalone	No Delay	No	L			X	X	Cooperative: RA + ADS-B + Radar
B	TA	On	JADEM	Standalone	WCR Only	No	L			X	X	Cooperative: ADS-B + Radar
C	TA/RA	On	JADEM	Standalone	No Delay	No	M		X			Cooperative: RA + Mode C + Radar
D	TA	On	JADEM	Standalone	No Delay	No	M		X			Cooperative: Mode C + Radar
E	TA/RA	On	JADEM	Standalone	No Delay	No	M	X				Non-cooperative: Radar only
F	TA/RA	On	DAIDULUS	Standalone	No Delay	No	L			X	X	Cooperative: RA + ADS-B + Radar
G	TA	On	DAIDULUS	Standalone	WCR Only	No	L			X	X	Cooperative: ADS-B + Radar
H	TA/RA	On	DAIDULUS	Standalone	No Delay	No	M		X			Cooperative: RA + Mode C + Radar
I	TA	On	DAIDULUS	Standalone	No Delay	No	M		X			Cooperative: Mode C + Radar
J	TA/RA	On	DAIDULUS	Standalone	No Delay	No	M	X				Non-cooperative: Radar only
K	TA/RA	On	CPDS	Standalone	No Delay	No	L			X	X	Cooperative: RA + ADS-B + Radar
L	TA	On	CPDS	Standalone	WCR Only	No	L			X	X	Cooperative: ADS-B + Radar
M	TA/RA	On	CPDS	Standalone	No Delay	No	M		X			Cooperative: RA + Mode C + Radar
N	TA	On	CPDS	Standalone	No Delay	No	M		X			Cooperative: Mode C + Radar
O	TA/RA	On	CPDS	Standalone	No Delay	No	M	X				Non-cooperative: Radar only
P	TA/RA	On	JADEM	Standalone	No Delay	No	Intruder #1: ADS-B + TCAS II; Intruder #2: ADS-B + TCAS II					
Q	TA/RA	On	JADEM	Standalone	No Delay	No	Intruder #1: Non-cooperative; Intruder #2: ADS-B + TCAS II					
R	TA/RA	On	JADEM	Standalone	No Delay	No	Both intruders: non-cooperative					
S	TA/RA	On	DAIDULUS	Standalone	No Delay	No	Intruder #1: ADS-B + TCAS II; Intruder #2: ADS-B + TCAS II					
T	TA/RA	On	DAIDULUS	Standalone	No Delay	No	Intruder #1: Non-cooperative; Intruder #2: ADS-B + TCAS II					
U	TA/RA	On	DAIDULUS	Standalone	No Delay	No	Both intruders: non-cooperative					
V	TA/RA	On	CPDS	Standalone	No Delay	No	Intruder #1: ADS-B + TCAS II; Intruder #2: ADS-B + TCAS II					
W	TA/RA	On	CPDS	Standalone	No Delay	No	Intruder #1: Non-cooperative; Intruder #2: ADS-B + TCAS II					
X	TA/RA	On	CPDS	Standalone	No Delay	No	Both intruders: non-cooperative					

- Total of 24 different test configurations.

Summary of Encounter Geometries

Scenario #	Ownship Airspeed (KIAS)	Ownship Alt (ft)	Ownship V Rate (ft/min)	Intruder Airspeed (KIAS)	Intruder Alt (ft)	Intruder V Rate (ft/min)	Intruder T Rate (deg/sec)	Intruder IA (deg)	Intruder HMD (ft)	Intruder VMD (ft)	ATC	Weather	Airspace* Class	Notes
1	150	7,700	0	173	8,000	0	0.0	180.0	2,400	300	Selected Cases	VMC	N/A	Level Head-on - low altitude/speed.
2	200	16,700	0	500	17,000	0	0.0	180.0	2,400	500	Selected Cases	VMC	N/A	Level Head-on - high altitude/speed.
3	150	varying	1000	173	8,000	0	0.0	180.0	2,400	300	Selected Cases	VMC	N/A	Ascending Head-on - low altitude/speed.
4	200	varying	1000	500	17,000	0	0.0	180.0	2,400	500	Selected Cases	VMC	N/A	Ascending Head-on - high altitude/speed.
5	150	varying	-1000	173	8,000	0	0.0	180.0	2,400	-300	Selected Cases	VMC	N/A	Descending Head-on.
6	150	7,700	0	173	8,000	0	0.0	90.0	2,400	300	Selected Cases	VMC	N/A	Level Abeam with intruder from right side - low altitude/speed.
7	200	16,700	0	500	17,000	0	0.0	90.0	2,400	500	Selected Cases	VMC	N/A	Level Abeam with intruder from right side - high altitude/speed.
8	150	7,700	0	173	8,000	0	0.0	270.0	2,400	300	Selected Cases	VMC	N/A	Level Abeam with intruder from left side.
9	150	varying	1000	173	8,000	0	0.0	270.0	2,400	300	Selected Cases	VMC	N/A	Ascending Abeam with intruder from left side (OSED N-4).
10	150	7,700	0	173	varying	-1500	0.0	270.0	2,400	300	Selected Cases	VMC	N/A	Ownship levels. Intruder descending and converging from left side of UAS (OSED N-3)
11	150	7,700	0	100	8,000	0	0.0	0.0	2,400	300	Selected Cases	VMC	N/A	Fast Level Overtake.
12	150	7,700	0	140	8,000	0	0.0	0.0	2,400	300	Selected Cases	VMC	N/A	Slow Level Overtake.
13	150	varying	-1000	100	8,000	0	0.0	0.0	2,400	-300	Selected Cases	VMC	N/A	Descending Fast Overtake.
14	150	varying	1000	173	varying	-1500	0.0	180.0	2,400	300	Selected Cases	VMC	N/A	Ascending Head-on with a descending intruder. CPA at 6000ft.
15	150	varying	1000	173	varying	-1500	0.0	180.0	2,400	1000	Selected Cases	VMC	N/A	Asending Head-on with a descending intruder that levels off 1000ft above. CPA at 6000ft.
16	150	7,700	0	173	8,000	0	3.0	180.0	-2,400	300	Selected Cases	VMC	N/A	Level Head-on with a turning intruder converging from right.
17	150	7,700	0	100	8,000	0	-3.0	90.0	2,400	300	Selected Cases	VMC	N/A	Level Abeam with a turning intruder converging from right.
18	150	7,700	0	100	8,000	0	3.0	270.0	2,400	300	Selected Cases	VMC	N/A	Level Abeam with a turning intruder converging from left.
19	150	varying	-1000	173	8,000	0	3.0	225.0	2,400	-300	Selected Cases	VMC	N/A	Descending with an intruder converging from left and turning right after SS maneuver (OSED N-10)
20	150	7,700	0	100	8,000	0	-3.0	0.0	2,400	300	Selected Cases	VMC	N/A	Level Overtake of a turning intruder.
21	150	varying	1000	100	8,000	0	-3.0	0.0	-2,400	300	Selected Cases	VMC	N/A	Ascending Overtake of a turning intruder
22	150	7,700	0	173	8,000	0	varying	225.0	2,400	300	Selected Cases	VMC	N/A	Level encounter with an intruder turns 45 deg and straight in from left.
23	150	7,700	0	173	8,000	0	varying	270.0	2,400	300	Selected Cases	VMC	N/A	Level encounter with an intruder turns 90 deg and straight in from left.
24	150	varying	1000	100	8,000	0	3.0	varying	3,200	300	Selected Cases	VMC	N/A	Climbing into a circling intruder (OSED N-2)

Summary of Encounter Geometries (cont'd)

Scenario #	Ownship Airspeed (KIAS)	Ownship Alt (ft)	Ownship V Rate (ft/min)	Intruder Airspeed (KIAS)	Intruder Alt (ft)	Intruder V Rate (ft/min)	Intruder T Rate (deg/sec)	Intruder IA (deg)	Intruder HMD (ft)	Intruder VMD (ft)	ATC	Weather	Airspace* Class	Notes
25	150	varying	1000	173	8,000	0	0.0	varying	2,400	300	Selected Cases	VMC	N/A	Climb and turn into a level intruder (OSED N-12)
26	150	7,700	0	173	8,000	varying	0.0	180.0	2,400	300	Selected Cases	VMC	N/A	Level Head-on with an intruder initially level but descending at 1500fpm toward the ownship.
27	150	8,000	0	173	varying	-1500	0.0	180.0	2,400	1000	Selected Cases	VMC	N/A	Head-on with an intruder initially descending but leveling off
28	150	8,000	0	173	varying	-1500	0.0	90.0	2,400	1000	Selected Cases	VMC	N/A	Abeam with an intruder initially descending but leveling off
29	150	8,000	0	173	varying	1500	0.0	180.0	2,400	-1000	Selected Cases	VMC	N/A	Head-on with an intruder initially ascending but leveling off
30	150	8,000	0	173	varying	1500	0.0	90.0	2,400	-1000	Selected Cases	VMC	N/A	Abeam with an intruder initially ascending but leveling off
31	150	10,000	0	Multiple Intruder Geometry							Selected Cases	VMC	N/A	Sandwiched by two head-on intruders horizontally
32	150	10,000	0	Multiple Intruder Geometry							Selected Cases	VMC	N/A	Sandwiched by two head-on intruders vertically
33	150	10,000	0	Multiple Intruder Geometry							Selected Cases	VMC	N/A	Encounter with one parallel intruder and one turning intruder
34	150	10,000	0	Multiple Intruder Geometry							Selected Cases	VMC	N/A	Encounter with two intruders above and one descends to avoid collision.
35	150	10,000	0	Multiple Intruder Geometry							Selected Cases	VMC	N/A	Overtake an intruder above with a second intruder below in oppostie direction (OSED N-7)

* Airspace Class is handled inherently (i.e., speeds/altitudes are consistent with airspace classification).

- Total of 35 different encounter geometries:
  - 14 straight single intruder scenarios
  - 16 maneuvering single intruder scenarios
  - 5 multiple intruder scenarios

Summary of Selected Flight Test Scenarios

Scenario #	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Notes	# of Scenarios
1			x	x						x	x	x			x										Level Head-on - low altitude/speed.	6
2						x					x														Level Head-on - high altitude/speed.	2
3																									Ascending Head-on - low altitude/speed.	0
4																									Ascending Head-on - high altitude/speed.	0
5																									Descending Head-on.	0
6			x	x						x															Level Abeam with intruder from right side - low altitude/speed.	3
7																									Level Abeam with intruder from right side - high altitude/speed.	0
8																									Level Abeam with intruder from left side.	0
9	x																								Ascending Abeam with intruder from left side (OSED N-4).	1
10																									Ownship levels. Intruder descending and converging from left side of UAS (OSED N-3)	0
11	x				x																				Fast Level Overtake.	2
12																									Slow Level Overtake.	0
13	x										x														Descending Fast Overtake.	2
14					x					x	x				x										Ascending Head-on with a descending intruder. CPA at 6000ft.	4
15	x					x					x														Asending Head-on with a descending intruder that levels off 1000ft above. CPA at 6000ft.	3
16	x				x	x				x	x				x										Level Head-on with a turning intruder converging from right.	6
17																									Level Abeam with a turning intruder converging from right.	0
18																									Level Abeam with a turning intruder converging from left.	0
19																									Descending with an intruder converging from left and turning right after SS maneuver (OSED	0
20					x					x					x										Level Overtake of a turning intruder.	3
21																									Ascending Overtake of a turning intruder	0
22																									Level encounter with an intruder turns 45 deg and straight in from left.	0
23																									Level encounter with an intruder turns 90 deg and straight in from left.	0
24	x					x					x														Climbing into a circling intruder (OSED N-2)	3
25	x					x					x														Climb and turn into a level intruder (OSED N-12)	3
26																									Level Head-on with an intruder initially level but descending at 1500fpm toward the ownship.	0
27	x					x					x														Head-on with an intruder initially descending but leveling off	3
28																									Abeam with an intruder initially descending but leveling off	0
29																									Head-on with an intruder initially ascending but leveling off	0
30																									Abeam with an intruder initially ascending but leveling off	0
31																x	x			x					Sandwiched by two head-on intruders horizontally	3
32																				x		x	x		Sandwiched by two head-on intruders vertically	3
33																									Encounter with one parallel intruder and one turning intruder	0
34																									Encounter with two intruders above and one descends to avoid collision.	0
35																	x			x		x	x		Overtake an intruder above with a second intruder below in oppostie direction (OSED N-7)	4
																									Totoal # of Scenarios:	**51**

Covered by other FT4 participants

x Selected by SC-228

- Total of 51 flight test scenarios

Single Non-accelerating Intruder

FT4 TEST OBJECTIVES – SC228 Scenario #1 (Conf. 1-C)

Evaluate DAA system and subsystem performance for a level head-on encounter with a medium Mode C intruder (mitigated, medium closure rate, <10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

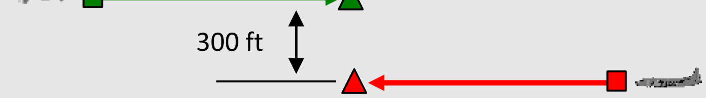
System Under Test: Omnibands

Display: *VSCS*

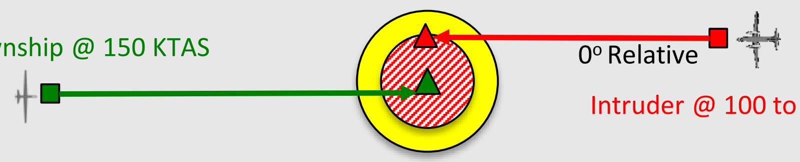
TCAS II	ADS-B	Radar	Tracker
TA/RA	YES	YES	YES

RCS	Mode C	ADS-B	TCAS II
M	YES	NO	NO

USAF C-12 @ 173 KTAS preferred;
if not, then TG-14 @100 KTAS



Scenario(s): #242



Lateral Offset = 0.4 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 300 ft

Test Objectives (TO)

1. Collect Mode-C and radar data and fusion tracker data
2. Collect pilot/system performance data with Omnibands guidance and potential TCAS RAs
3. Intruder equipage (i.e., Mode-C only) has priority over its speed and RCS.

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts generated and pilot followed the guidance correctly.
3. Data collected: TBD

Test Method

- MANEUVER: Pilot to manually select and execute 'minimum' maneuver at edge of band (or quantized altitude level). Pilot to follow TCAS RAs if generated.
- Aircraft speeds (non-accelerating): Ownship 150 KTAS, Intruder 100 to 173 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm., no DAA alerts displayed.
- Climb/Roll/Pitch Rates: 0/0/0
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance.
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

FT4 TEST OBJECTIVES – SC228 Scenario #2 (Conf. 1-D)

Evaluate DAA system and subsystem performance for a level head-on encounter with a medium Mode C intruder (mitigated, medium closure rate, <10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

System Under Test: Omnibands

Display: *VSCS*

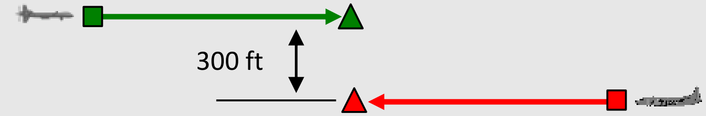
Contributing Sensors (Ownship):

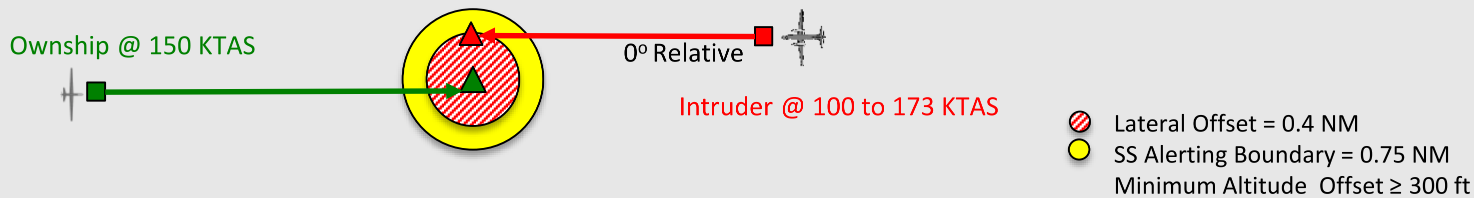
TCAS II	ADS-B	Radar	Tracker
TA	YES	YES	YES

Intruder Equipage:

RCS	Mode C	ADS-B	TCAS II
M	YES	NO	NO

USAF C-12 @ 173 KTAS preferred;
if not then TG-14 @ 100 KTAS.





Scenario(s): #243

Test Objectives (TO)

1. Same as the previous scenario (scenario #1) except TCAS II is placed in TA-only mode for this scenario and hence, no RA is expected. This will allow SS guidance provided by Omnibands to play out without interplays caused by TCAS RAs.

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts generated and pilot followed the guidance correctly.
3. Data collected: TBD

Test Method

- MANUEVER: Pilot to manually select and execute 'minimum' maneuver at edge of band (or quantized altitude level).
- Aircraft speeds (non-accelerating): Ownship 150 KTAS, Intruder 100 to173 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm, no DAA alerts displayed.
- Expected guidance: TBD
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

FT4 TEST OBJECTIVES – SC228 Scenario #3 (Conf. 1-J)

Evaluate DAA system and subsystem performance for a level head-on encounter with a medium non-cooperative intruder (mitigated, medium closure rate, <10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

System Under Test: **DAIDALUS**

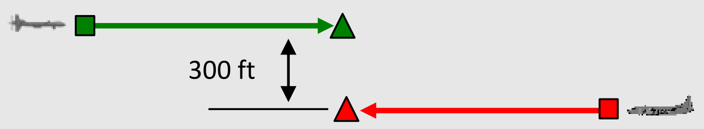
Display: *Native display*

Contributing Sensors (Ownship):

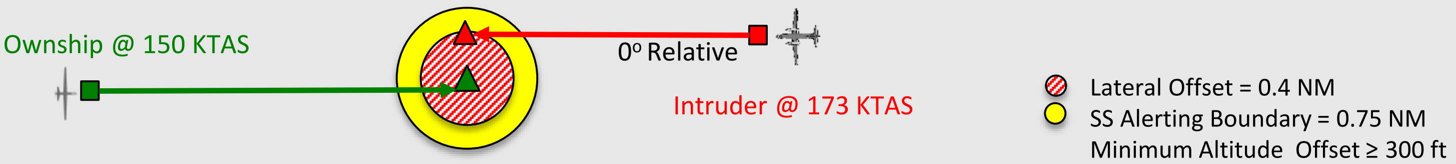
TCAS II	ADS-B	Radar	Tracker
NO	NO	YES	YES

Intruder Equipage:

RCS	Mode C	ADS-B	TCAS II
M/L	ON if equipped	ON if equipped	ON if equipped



Scenario(s): #244



Test Objectives (TO)

1. Collect radar data and fusion tracker data (operating with single sensor only)
2. Collect pilot/system performance data with DAIDALUS guidance
3. Intruder equipage is not a factor. Intruder speed has priority over RCS (medium is preferred but large is acceptable).

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts generated and pilot followed the guidance correctly.
3. Data collected: TBD

Test Method

- MANEUVER: Follow guidance to remain well clear.
- Aircraft speeds (non-accelerating): Ownship 150 KTAS, Intruder 173 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm, no DAA alerts displayed.
- Expected guidance: TBD
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

FT4 TEST OBJECTIVES – SC228 Scenario #4 (Conf. 1-K)

Evaluate DAA system and subsystem performance for a level head-on encounter with a large TCAS/ADS-B intruder (mitigated, medium closure rate, <10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

System Under Test: CPDS

Display: *CDTI/VPD*

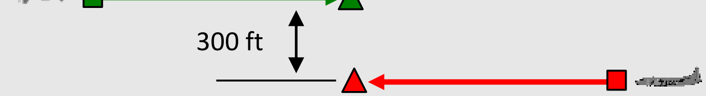
Contributing Sensors (Ownship):

TCAS II	ADS-B	Radar	Tracker
TA/RA	YES	YES	YES

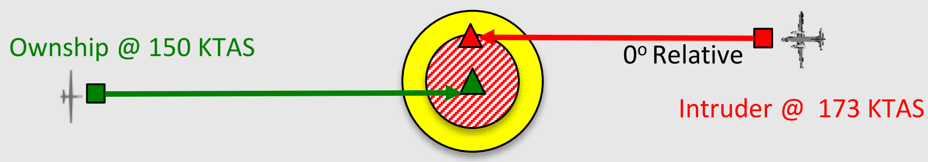
Intruder Equipage:

RCS	Mode C	ADS-B	TCAS II
L	NO	YES	YES

(N3GC or GIII)



Scenario(s): #245



Lateral Offset = 0.4 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 300 ft

Test Objectives (TO)

1. Collect Mode-S, ADS-B, and radar data and fusion tracker data
2. Collect pilot/system performance data with CPDS guidance and potential TCAS RAs

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts generated and pilot followed the guidance correctly.
3. Data collected: TBD

Test Method

- MANUEVER: Follow guidance to remain well clear. Follow TCAS RAs if generated.
- Aircraft speeds (non-accelerating): Ownship 150 KTAS, Intruder 173 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm, no DAA alerts displayed.
- Expected guidance: TBD
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: Medium.

FT4 TEST OBJECTIVES – SC228 Scenario #5 (Conf. 1-L)

Evaluate DAA system and subsystem performance for a level head-on encounter with a large TCAS/ADS-B intruder (mitigated - WCR only, medium closure rate, <10kft MSL)	MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

System Under Test: CPDS

Display: *CDTI/VPD*

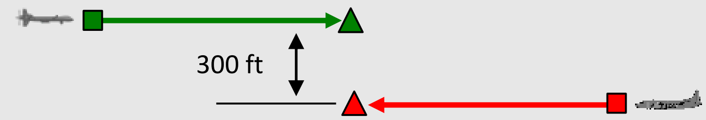
Contributing Sensors (Ownship):

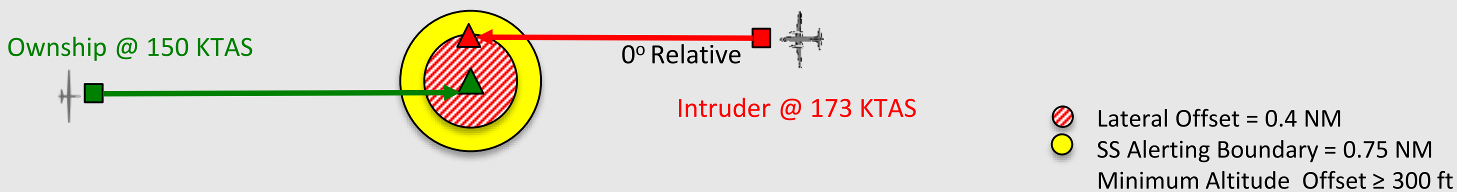
TCAS II	ADS-B	Radar	Tracker
TA/RA	YES	YES	YES

Intruder Equipage:

RCS	Mode C	ADS-B	TCAS II
L	NO	YES	YES

(N3GC or GIII)





Scenario(s): #246

Test Objectives (TO)	1. Same as the previous scenario (scenario #4) except this scenario focuses on testing well clear recover (WCR) guidance.
Success Criteria (retest if criteria not met)	1. Scenario executed as specified. 2. DAA alerts generated and pilot followed the guidance correctly. 3. Data collected: TBD
Test Method	• MANUEVER: Ignore SS guidance until WCR guidance is issued and then follow WCR guidance to regain well clear. Follow TCAS RAs if generated.. • Aircraft speeds (non-accelerating): Ownship 150 KTAS, Intruder 173 KTAS • Encounter Length: 2 min (IP to CPA) • Stable Conditions: stable at the IP (2 minutes prior to CPA) • Test Termination Criteria: targets diverging, range > 0.75 nm, no DAA alerts displayed. • Expected guidance: TBD • Tolerance: ± 8 sec, ± 5 kts at IP crossing.
Evaluation Criteria (Post-test analysis to determine if test objectives are met)	1. Sensor provides data with expected performance. 2. Sensor data processing and tracking provides integrated track with expected performance. 3. UAS pilot receives DAA corrective alert with associated guidance 4. DAA alert(s) and guidance are removed once ownship is clear of threat. 5. CPA prediction accuracy sufficient for DAA function.
Additional Information	**Priority: High.**

FT4 TEST OBJECTIVES – SC228 Scenario #6 (Conf. 1-O)

Evaluate DAA system and subsystem performance for a level head-on encounter with a medium non-cooperative intruder (mitigated, medium closure rate, <10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

System Under Test: CPDS

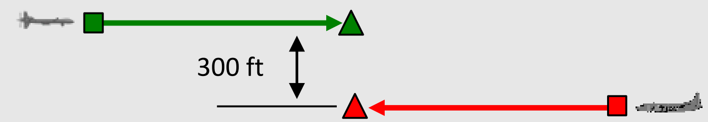
Display: *CDTI/VPD*

Contributing Sensors (Ownship):

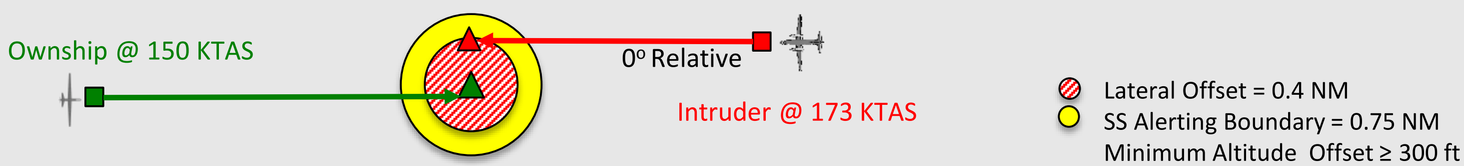
TCAS II	ADS-B	Radar	Tracker
NO	NO	YES	YES

Intruder Equipage:

RCS	Mode C	ADS-B	TCAS II
M/L	ON if equipped	ON if equipped	ON if equipped



Scenario(s): #247



Test Objectives (TO)

1. Collect radar data and fusion tracker data (single sensor only)
2. Collect pilot/system performance data with CPDS guidance
3. Intruder equipage is not a factor. Intruder speed has priority over RCS (medium is preferred but large is acceptable).

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts generated and pilot followed the guidance correctly.
3. Data collected: TBD

Test Method

- MANUEVER: Follow SS guidance to remain well clear.
- Aircraft speeds (non-accelerating): Ownship 150 KTAS, Intruder 173 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm, no DAA alerts displayed.
- Expected guidance: TBD
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

FT4 TEST OBJECTIVES – SC228 Scenario #7 (Conf. 2-F)

Evaluate DAA system and subsystem performance for a level head-on encounter with a large TCAS/ADS-B intruder (mitigated, high closure rate, >10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

System Under Test: **DAIDALUS**

Display: *Native display*

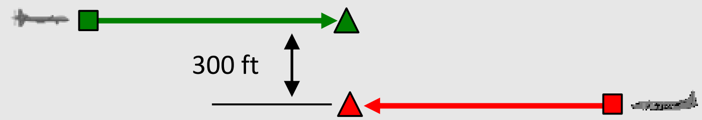
Contributing Sensors (Ownship):

TCAS II	ADS-B	Radar	Tracker
TA/RA	YES	YES	YES

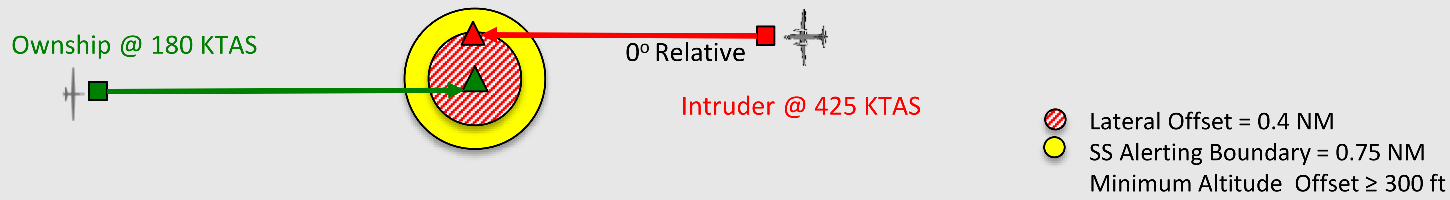
Intruder Equipage:

RCS	Mode C	ADS-B	TCAS II
L	NO	YES	YES

(GIII)



Scenario(s): #248



Test Objectives (TO)

1. Main focus on high-speed, high-altitude operation
2. Collect Mode-S, ADS-B, and radar data and fusion tracker data
3. Collect pilot/system performance data with DAIDALUS guidance and potential TCAS RAs

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts generated and pilot followed the guidance correctly.
3. Data collected: TBD

Test Method

- MANUEVER: Follow SS guidance to remain well clear. Follow TCAS RAs if generated.
- Aircraft speeds (non-accelerating): Ownship 180 KTAS, Intruder 425 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm, no DAA alerts displayed.
- Expected guidance: TBD
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

FT4 TEST OBJECTIVES – SC228 Scenario #8 (Conf. 2-K)

Evaluate DAA system and subsystem performance for a level head-on encounter with a large TCAS/ADS-B intruder (mitigated, high closure rate, >10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

System Under Test: CPDS

Display: *CDTI/VPD*

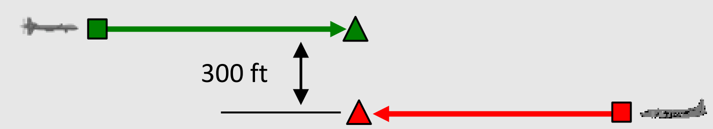
Contributing Sensors (Ownship):

TCAS II	ADS-B	Radar	Tracker
TA/RA	YES	YES	YES

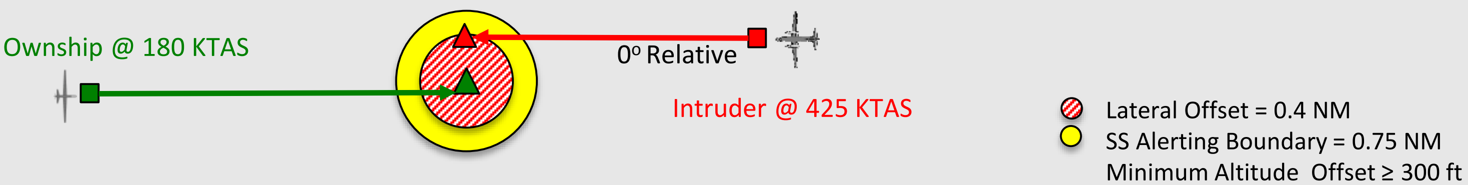
Intruder Equipage:

RCS	Mode C	ADS-B	TCAS II
L	NO	YES	YES

(GIII)



Scenario(s): #249



Test Objectives (TO)

1. Same as the previous scenario (scenario #7) except SS guidance is provided by CPDS.

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts generated and pilot followed the guidance correctly.
3. Data collected: TBD

Test Method

- MANUEVER: Follow SS guidance to remain well clear. Follow TCAS RAs if generated.
- Aircraft speeds (non-accelerating): Ownship 180 KTAS, Intruder 425 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm, no DAA alerts displayed.
- Expected guidance: TBD
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

FT4 TEST OBJECTIVES – SC228 Scenario #9 (Conf. 6-C)

Evaluate DAA system and subsystem performance for a level abeam encounter with medium Mode C intruder from right side (mitigated, medium closure rate, <10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

Scenario(s): #250

System Under Test: Omnibands

Display: *VSCS*

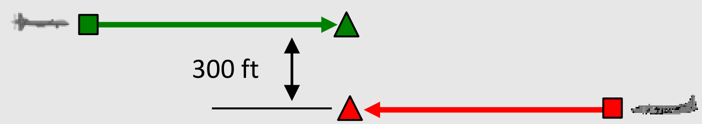
Contributing Sensors (Ownship):

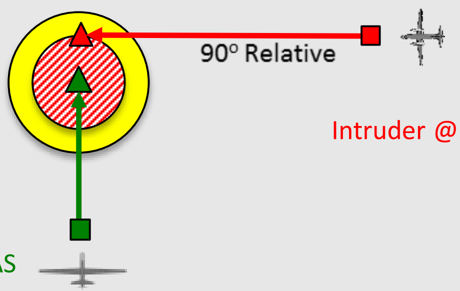
TCAS II	ADS-B	Radar	Tracker
TA/RA	YES	YES	YES

Intruder Equipage:

RCS	Mode C	ADS-B	TCAS II
M	YES	NO	NO

USAF C-12 @ 173 KTAS preferred; if not, then TG-14 @ 100 KTAS.





Test Objectives (TO)

1. Collect Mode-C and radar data and fusion tracker data
2. Collect pilot/system performance data with Omnibands guidance and potential TCAS RAs
3. Intruder equipage (i.e., Mode-C only) has priority over its speed and RCS.

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts generated and pilot followed the guidance correctly.
3. Data collected: TBD

Test Method

- MANUEVER: Pilot to manually select and execute 'minimum' maneuver at edge of band (or quantized altitude level). Pilot to follow TCAS RAs if generated.
- Aircraft speeds (non-accelerating): Ownship 150 KTAS, Intruder 100 to 173 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm., no DAA alerts displayed.
- Climb/Roll/Pitch Rates: 0/0/0
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance.
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

FT4 TEST OBJECTIVES – SC228 Scenario #10 (Conf. 6-D)

Evaluate DAA system and subsystem performance for a level Abeam encounter with a medium Mode C intruder (mitigated, medium closure rate, <10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

Scenario(s): #251

System Under Test: Omnibands

Display: *VSCS*

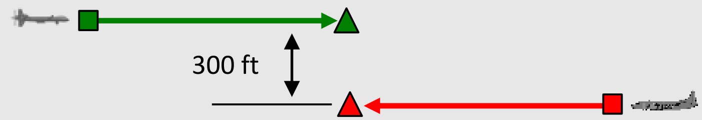
Contributing Sensors (Ownship):

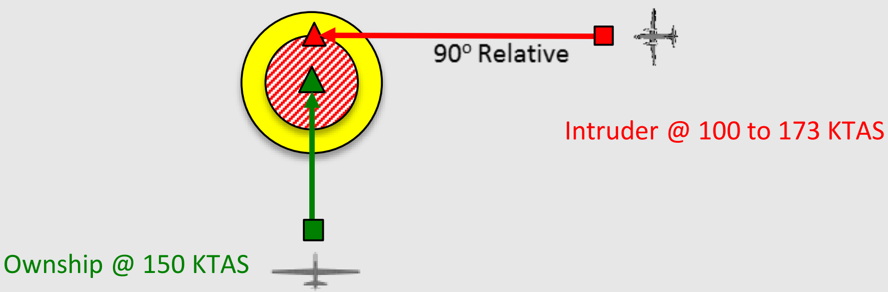
TCAS II	ADS-B	Radar	Tracker
TA	YES	YES	YES

Intruder Equipage:

RCS	Mode C	ADS-B	TCAS II
M	YES	NO	NO

USAF C-12 @ 173 KTAS preferred, if not, then TG-14 @ 100 KTAS.





Lateral Offset = 0.4 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 300 ft

Test Objectives (TO)

1. Same as the previous scenario (scenario #9) except TCAS II is placed in TA-only mode for this scenario and hence, no RA is expected. This will allow SS guidance provided by Omnibands to play out without interplays caused by TCAS RAs.

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts generated and pilot followed the guidance correctly.
3. Data collected: TBD

Test Method

- MANUEVER: Pilot to manually select and execute 'minimum' maneuver at edge of band (or quantized altitude level).
- Aircraft speeds (non-accelerating): Ownship 150 KTAS, Intruder 100 to 173 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm, no DAA alerts displayed.
- Expected guidance: TBD
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

FT4 TEST OBJECTIVES – SC228 Scenario #11 (Conf. 6-J)

Evaluate DAA system and subsystem performance for a level abeam encounter with medium non-cooperative intruder from right side (mitigated, medium closure rate, <10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

System Under Test: DAIDALUS

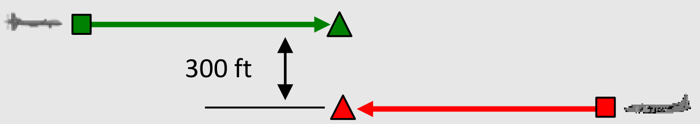
Display: *Native display*

Contributing Sensors (Ownship):

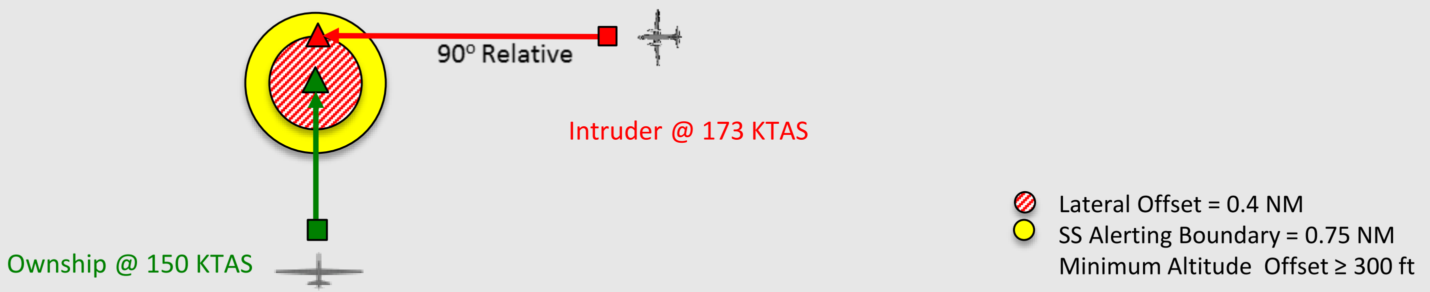
TCAS II	ADS-B	Radar	Tracker
NO	NO	YES	YES

Intruder Equipage:

RCS	Mode C	ADS-B	TCAS II
M/L	ON if equipped	ON if equipped	ON if equipped



Scenario(s): #252



Test Objectives (TO)

1. Collect radar data and fusion tracker data (operating with single sensor only)
2. Collect pilot/system performance data with DAIDALUS guidance
3. Intruder equipage is not a factor. Intruder speed has priority over RCS (medium is preferred but large is acceptable).

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts generated and pilot followed the guidance correctly.
3. Data collected: TBD

Test Method

- MANUEVER: Follow SS guidance to remain well clear.
- Aircraft speeds (non-accelerating): Ownship 150 KTAS, Intruder 173 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm, no DAA alerts displayed.
- Expected guidance: TBD
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

FT4 TEST OBJECTIVES – SC228 Scenario #12 (Conf. 9-A)

Evaluate DAA system and subsystem performance for an ascending abeam encounter with a large cooperative intruder from left side (mitigated, medium closure rate, <10kft MSL)	**MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.**

Configuration

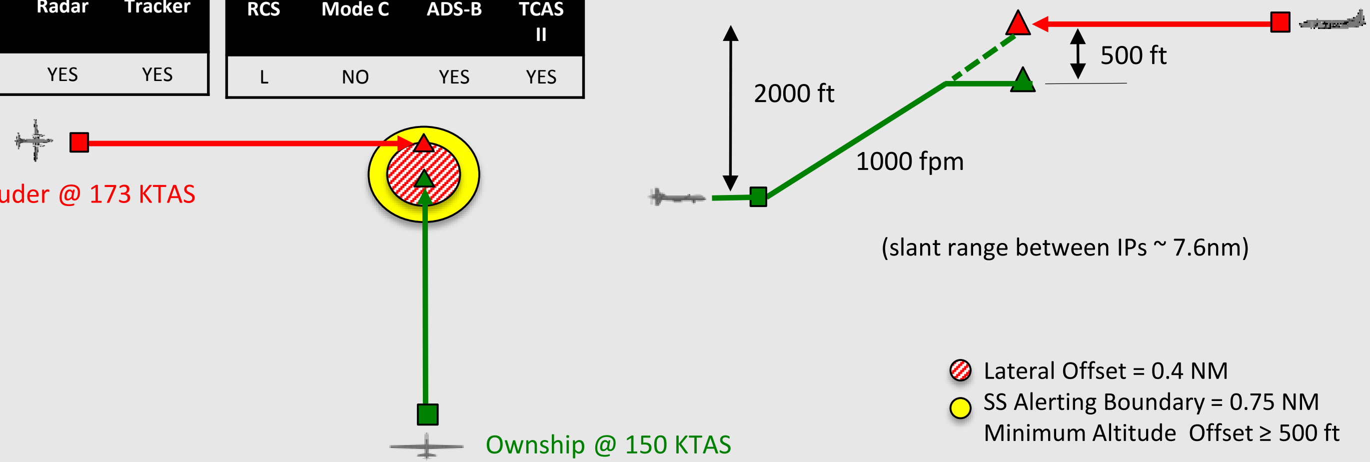
System Under Test: **Omnibands**
Display: *VSCS*
Contributing Sensors (Ownship):

TCAS II	ADS-B	Radar	Tracker
TA/RA	YES	YES	YES

Intruder Equipage:

RCS	Mode C	ADS-B	TCAS II
L	NO	YES	YES

Scenario(s): #253



Test Objectives (TO)	1. Collect Mode-S, ADS-B, and radar data and fusion tracker data 2. Collect pilot/system performance data with Ominbands guidance and potential TCAS RAs 3. Collect right of way data
Success Criteria (retest if criteria not met)	1. Scenario executed as specified. 2. DAA alerts generated and pilot followed the guidance correctly. 3. Data collected: TBD
Test Method	• MANUEVER: Follow SS guidance to remain well clear. Follow TCAS RAs if triggered. • Aircraft speeds (non-accelerating): Ownship 150 KTAS, Intruder 173 KTAS • Encounter Length: 2 min (IP to CPA) • Stable Conditions: stable at the IP (2 minutes prior to CPA) • Test Termination Criteria: targets diverging, range > 0.75 nm, no DAA alerts displayed. • Expected guidance: TBD • Tolerance: ± 8 sec, ± 5 kts at IP crossing.
Evaluation Criteria (Post-test analysis to determine if test objectives are met)	1. Sensor provides data with expected performance. 2. Sensor data processing and tracking provides integrated track with expected performance. 3. UAS pilot receives DAA corrective alert with associated guidance 4. DAA alert(s) and guidance are removed once ownship is clear of threat. 5. CPA prediction accuracy sufficient for DAA function.
Additional Information	**Priority: High.**

FT4 TEST OBJECTIVES – SC228 Scenario #13 (Conf. 11-A)

Evaluate DAA system and subsystem performance for a fast level overtake encounter with a cooperative intruder (mitigated, low closure rate, <10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

System Under Test: Omnibands

Display: *VSCS*

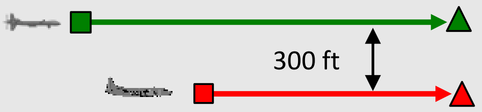
Contributing Sensors (Ownship):

TCAS II	ADS-B	Radar	Tracker
TA/RA	YES	YES	YES

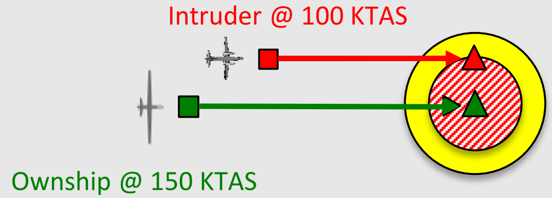
Intruder Equipage:

RCS	Mode C	ADS-B	TCAS II
M/L	NO	YES	NO

(T-34 or TG-14)



(Virtual offset can be used if 500ft physical separation is required for safety reason)



Lateral Offset = 0.4 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 300 ft

(Key requirement is to maintain closure rate to 40 – 50 KTAS)

Scenario(s): #254

Test Objectives (TO)

1. Collect TCAS, ADS-B, and radar data and fusion tracker data.
2. Collect pilot/system performance data with Omnibands guidance and its interplays with TCAS RAs.
3. Key requirement for this scenario is to maintain closure rate to 40 – 50 KTAS. The absolute speeds are less important. For example, 180 vs 130 KTAS would work too.

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts generated and pilot followed the guidance correctly.
3. Data collected: TBD

Test Method

- MANUEVER: Follow SS guidance to remain well clear. Follow TCAS RAs if triggered.
- Aircraft speeds (non-accelerating): Ownship/Intruder speeds: 150/100 KTAS or 180/130 KTAS
- Encounter Length: 3 min (IP to CPA)
- Stable Conditions: stable at the IP (3 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm, no DAA alerts displayed.
- Expected guidance: TBD
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

FT4 TEST OBJECTIVES – SC228 Scenario #14 (Conf. 11-E)

Evaluate DAA system and subsystem performance for a fast level overtake encounter with a non-cooperative intruder (mitigated, low closure rate, <10kft MSL)	MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

System Under Test: Omnibands

Display: *VSCS*

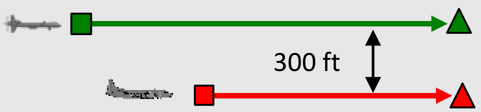
Contributing Sensors (Ownship):

TCAS II	ADS-B	Radar	Tracker
NO	NO	YES	YES

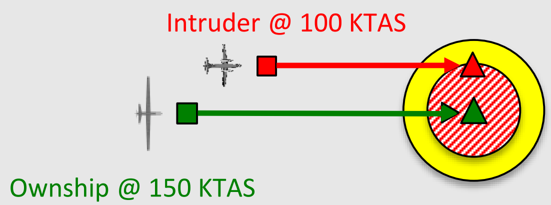
Intruder Equipage:

RCS	Mode C	ADS-B	TCAS II
M/L	ON if equipped	ON if equipped	ON if equipped

(T-34 or TG-14)



(Virtual offset can be used if 500ft physical separation is required for safety reason)



(Key requirement is to maintain closure rate to 40 – 50 KTAS)

Lateral Offset = 0.4 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 300 ft

Scenario(s): #255

Test Objectives (TO)

1. Same as the previous scenario (scenario #13) except the intruder is non-cooperative (i.e., radar data only for DAA processing) for this scenario. No TCAS RAs is expected.
2. Like the previous case, key requirement is to maintain closure rate to 40 – 50 KTAS. The absolute speeds are less important. For example, 180 vs 130 KTAS would work too. Intruder RCS is also less important (medium is preferred but large is acceptable).

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts generated and pilot followed the guidance correctly.
3. Data collected: TBD

Test Method

- MANUEVER: Follow SS guidance to remain well clear.
- Aircraft speeds (non-accelerating): Ownship/intruder speeds: 150 /100 KTAS or 180/130 KTAS
- Encounter Length: 3 min (IP to CPA)
- Stable Conditions: stable at the IP (3 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm, no DAA alerts displayed.
- Expected guidance: TBD
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

FT4 TEST OBJECTIVES – SC228 Scenario #15 (Conf. 13-A)

Evaluate DAA system and subsystem performance for a descending fast overtake encounter with a cooperative intruder (mitigated, low closure rate, <10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

Scenario(s): #256

System Under Test: Omnibands

Display: *VSCS*

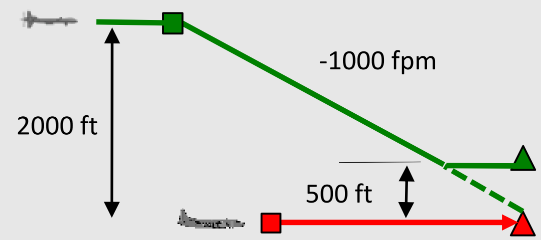
Contributing Sensors (Ownship):

TCAS II	ADS-B	Radar	Tracker
TA/RA	YES	YES	YES

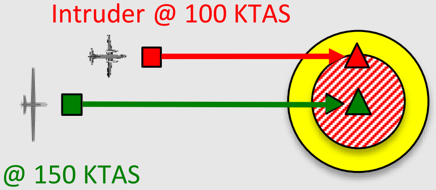
Intruder Equipage:

RCS	Mode C	ADS-B	TCAS II
M/L	NO	YES	NO

(T-34 or TG-14)



(slant range between two IPs ~ 1.7nm)



(Key requirement is to maintain closure rate to 40 – 50 KTAS)

Lateral Offset = 0.4 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 500 ft

Test Objectives (TO)	1. Collect TCAS, ADS-B, and radar data and fusion tracker data. 2. Collect pilot/system performance data with Omnibands guidance and its interplays with TCAS RAs. 3. Key requirement for this scenario is to maintain closure rate to 40 – 50 KTAS. The absolute speeds are less important. For example, 180 vs 130 KTAS would work too.
Success Criteria (retest if criteria not met)	1. Scenario executed as specified. 2. DAA alerts generated and pilot followed the guidance correctly. 3. Data collected: TBD
Test Method	• MANUEVER: Follow SS guidance to remain well clear. Follow TCAS RAs if triggered. • Aircraft speeds (non-accelerating): Ownship/intruder speeds: 150/100 KTAS or 180/130 KTAS. • Encounter Length: 2 min (IP to CPA) • Stable Conditions: stable at the IP (2 minutes prior to CPA) • Test Termination Criteria: targets diverging, range > 0.75 nm, no DAA alerts displayed. • Expected guidance: TBD • Tolerance: ± 8 sec, ± 5 kts at IP crossing.
Evaluation Criteria (Post-test analysis to determine if test objectives are met)	1. Sensor provides data with expected performance. 2. Sensor data processing and tracking provides integrated track with expected performance. 3. UAS pilot receives DAA corrective alert with associated guidance 4. DAA alert(s) and guidance are removed once ownship is clear of threat. 5. CPA prediction accuracy sufficient for DAA function.
Additional Information	**Priority: High.**

FT4 TEST OBJECTIVES – SC228 Scenario #16 (Conf. 13-K)

Evaluate DAA system and subsystem performance for a descending fast overtake encounter with a cooperative intruder (mitigated, low closure rate, <10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

Scenario(s): #257

System Under Test: CPDS

Display: *CDTI/VPD*

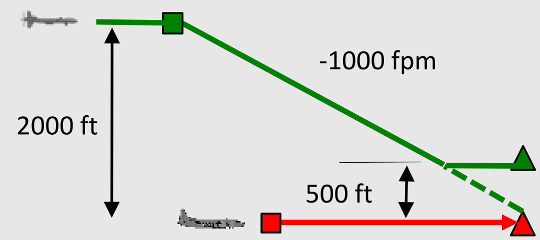
Contributing Sensors (Ownship):

TCAS II	ADS-B	Radar	Tracker
TA/RA	YES	YES	YES

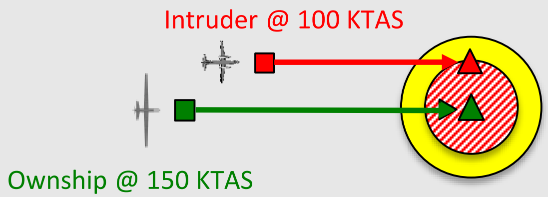
Intruder Equipage:

RCS	Mode C	ADS-B	TCAS II
M/L	NO	YES	NO

(T-34 or TG-14)



(slant range between two IPs ~ 1.7nm)



Lateral Offset = 0.4 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 500 ft

(Key requirement is to maintain closure rate to 40 – 50 KTAS)

Test Objectives (TO)

1. Same as previous scenario (scenario #15) except CPDS is used to provide SS guidance for this scenario.

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts generated and pilot followed the guidance correctly.
3. Data collected: TBD

Test Method

- MANUEVER: Follow SS guidance to remain well clear. Follow TCAS RAs if triggered.
- Aircraft speeds (non-accelerating): Ownship/intruder speeds: 150/100 KTAS or 180/130 KTAS.
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm, no DAA alerts displayed.
- Expected guidance: TBD
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

FT4 TEST OBJECTIVES – SC228 Scenario #17 (Conf. 14-E)

Evaluate DAA system and subsystem performance for ascending head-on with a descending non-cooperative intruder (mitigated, high vertical closure rate, <10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

System Under Test: Omnibands

Display: *VSCS*

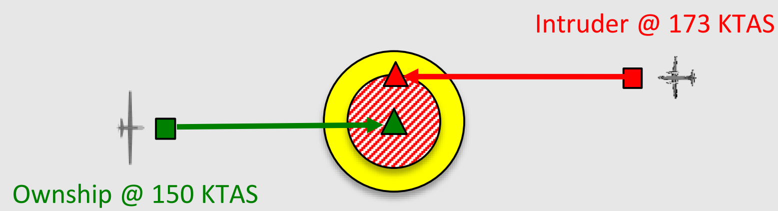
Contributing Sensors (Ownship):

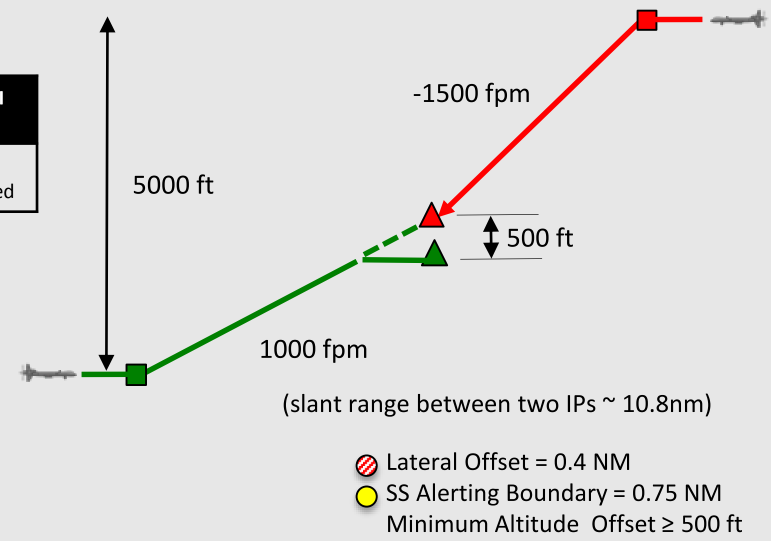
TCAS II	ADS-B	Radar	Tracker
NO	NO	YES	YES

Intruder Equipage:

RCS	Mode C	ADS-B	TCAS II
M/L	ON if equipped	ON if equipped	ON if equipped

Scenario(s): #258





Test Objectives (TO)

1. Collect radar data and fusion tracker data (operating with single sensor only)
2. Collect pilot/system performance data with Omnibands guidance
3. Intruder equipage is not a factor. Intruder speed has priority over RCS (medium is preferred but large is acceptable).

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts generated and pilot followed the guidance correctly.
3. Data collected: TBD

Test Method

- MANUEVER: Follow SS guidance to remain well clear.
- Aircraft speeds (non-accelerating): Ownship 150 KTAS, Intruder 173 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm, no DAA alerts displayed.
- Expected guidance: TBD
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

FT4 TEST OBJECTIVES – SC228 Scenario #18 (Conf. 14-J)

Evaluate DAA system and subsystem performance for ascending head-on with a descending non-cooperative intruder (mitigated, high vertical closure rate, <10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

System Under Test: DAIDALUS

Display: *Native display*

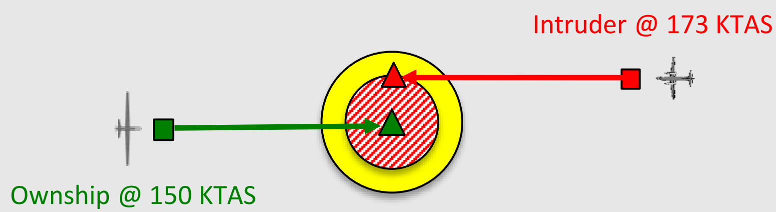
Contributing Sensors (Ownship):

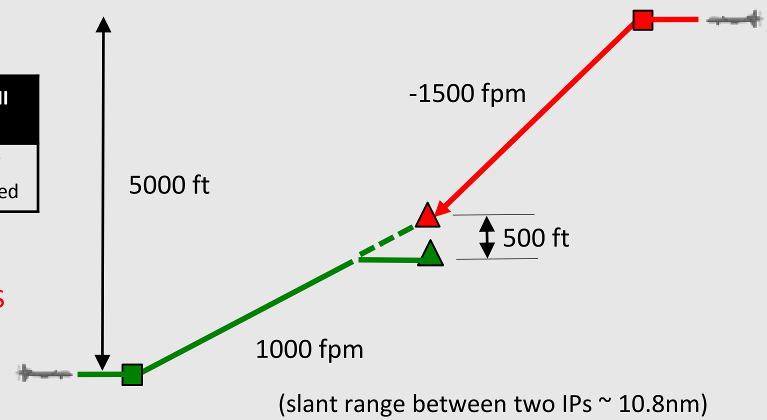
TCAS II	ADS-B	Radar	Tracker
NO	NO	YES	YES

Intruder Equipage:

RCS	Mode C	ADS-B	TCAS II
M/L	ON if equipped	ON if equipped	ON if equipped

Scenario(s): #259





Lateral Offset = 0.4 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 500 ft

Test Objectives (TO)

1. Same as previous scenario (scenario #17) except that DAIDALUS is used to provide SS guidance for this scenario.

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts generated and pilot followed the guidance correctly.
3. Data collected: TBD

Test Method

- MANUEVER: Follow SS guidance to remain well clear.
- Aircraft speeds (non-accelerating): Ownship 150 KTAS, Intruder 173 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm, no DAA alerts displayed.
- Expected guidance: TBD
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

FT4 TEST OBJECTIVES – SC228 Scenario #19 (Conf. 14-K)

Evaluate DAA system and subsystem performance for ascending head-on with a descending large cooperative intruder (mitigated, high vertical closure rate, <10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

Scenario(s): #260

System Under Test: CPDS

Display: *CDTI/VPD*

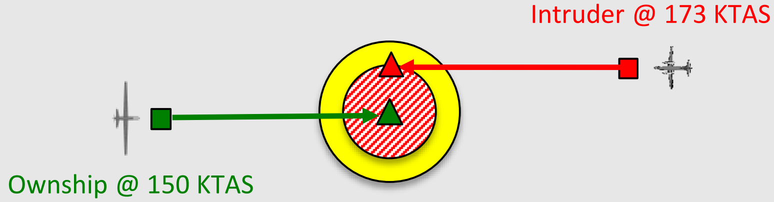
Contributing Sensors (Ownship):

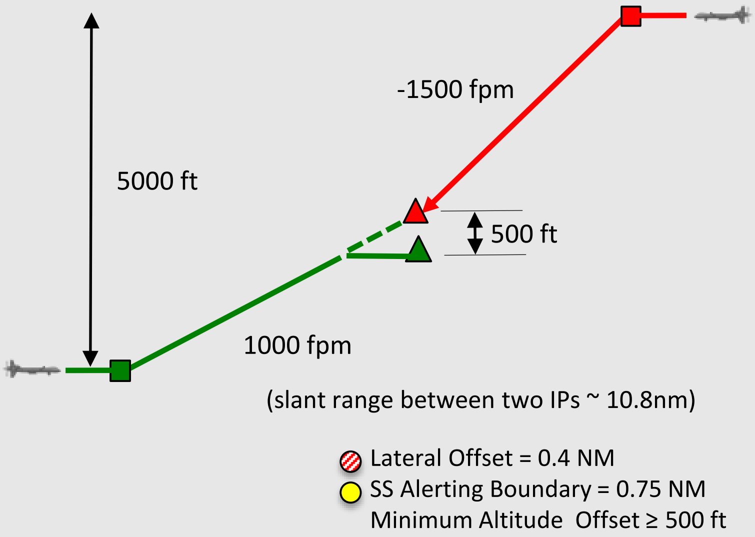
TCAS II	ADS-B	Radar	Tracker
TA/RA	YES	YES	YES

Intruder Equipage:

RCS	Mode C	ADS-B	TCAS II
L	NO	YES	YES

(N3GC)





Test Objectives (TO)

1. Collect TCAS, ADS-B, and radar data and fusion tracker data.
2. Collect pilot/system performance data with CPDS guidance and its interplays with TCAS RAs.

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts generated and pilot followed the guidance correctly.
3. Data collected: TBD

Test Method

- MANUEVER: Follow SS guidance to remain well clear. Follow TCAS RAs if triggered.
- Aircraft speeds (non-accelerating): Ownship 150 KTAS, Intruder 173 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm, no DAA alerts displayed.
- Expected guidance: TBD
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

FT4 TEST OBJECTIVES – SC228 Scenario #20 (Conf. 14-O)

Evaluate DAA system and subsystem performance for ascending head-on with a descending non-cooperative intruder (mitigated, high vertical closure rate, <10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

Scenario(s): #261

System Under Test: CPDS

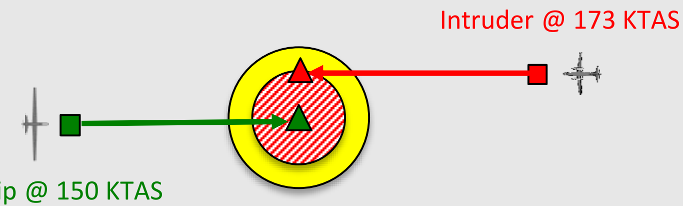
Display: *CDTI/VPD*

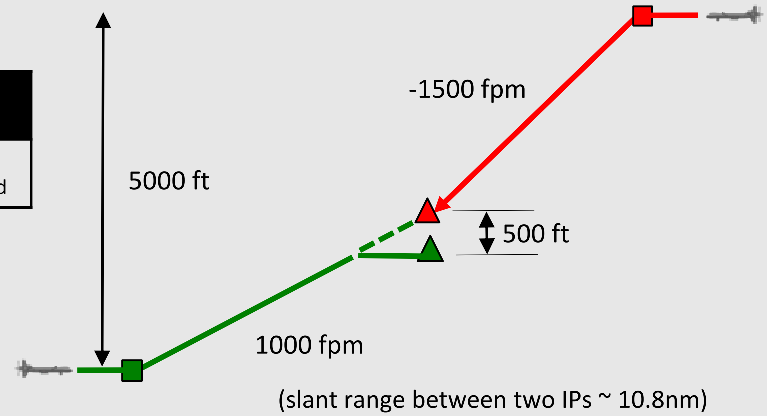
Contributing Sensors (Ownship):

TCAS II	ADS-B	Radar	Tracker
NO	NO	YES	YES

Intruder Equipage:

RCS	Mode C	ADS-B	TCAS II
M/L	ON if equipped	ON if equipped	ON if equipped





Lateral Offset = 0.4 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 500 ft

Test Objectives (TO)

1. Same as previous scenarios (scenarios #17 & 18) except CPDS is used to provide SS guidance for this scenario.

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts generated and pilot followed the guidance correctly.
3. Data collected: TBD

Test Method

- MANUEVER: Follow SS guidance to remain well clear.
- Aircraft speeds (non-accelerating): Ownship 150 KTAS, Intruder 173 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm, no DAA alerts displayed.
- Expected guidance: TBD
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

Single Maneuvering Intruder

FT4 TEST OBJECTIVES – SC228 Scenario #21 (Conf. 15-A)

Objective	MOPS Sections
Evaluate DAA system and subsystem performance for a vertical closure encounter with a large TCAS/ADS-B intruder (mitigated, high vertical closure rate, <10kft MSL)	**MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.**

Configuration

System Under Test: **Omnibands**

Display: *VSCS*

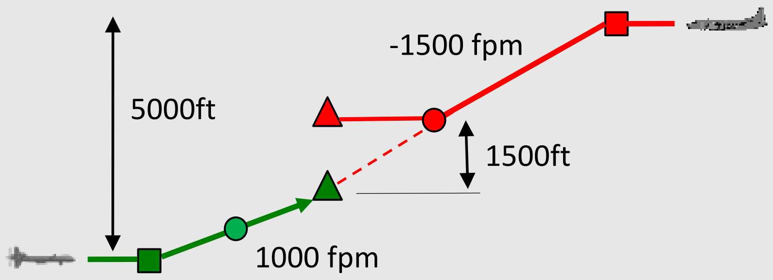
Contributing Sensors (Ownship):

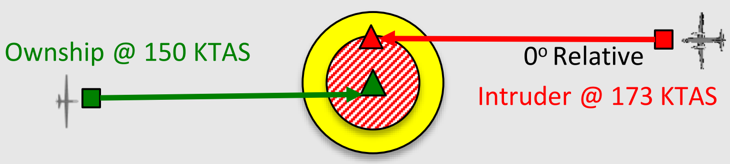
TCAS II	ADS-B	Radar	Tracker
TA/RA	YES	YES	YES

Intruder Equipage:

RCS	Mode C	ADS-B	TCAS II
L	NO	YES	YES

(N3GC)





(slant range between two IPs ~ 10.8nm;
slant range @ maneuvering point ~ 5.8nm)

Lateral Offset = 0.4 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 1500 ft

Scenario(s): #262

Test Objectives (TO)

1. This scenario is designed to test the chance of false alert under high vertical closure rate condition given the MOPS alerting threshold.

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts: TBD
3. Data collected: TBD

Test Method

- MANUEVER: No pilot maneuver is expected.
- Aircraft speeds (non-accelerating): Ownship 150 KTAS, Intruder 173 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm, no DAA alerts displayed.
- Climb Rate: Ownship 1000 fpm, Intruder -1500 fpm
- Expected guidance: Intermittent corrected alerts but no warning alert. No TCAS RA is expected.
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

FT4 TEST OBJECTIVES – SC228 Scenario #22 (Conf. 15-F)

Evaluate DAA system and subsystem performance for a vertical closure encounter with a large TCAS/ADS-B intruder (mitigated, high vertical closure rate, <10kft MSL)	MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

System Under Test: DAIDALUS

Display: *Native display*

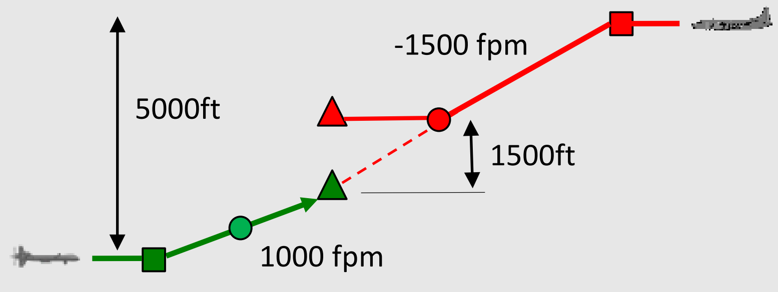
Contributing Sensors (Ownship):

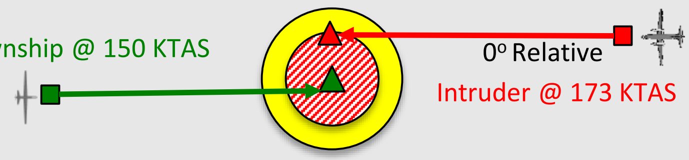
TCAS II	ADS-B	Radar	Tracker
TA/RA	YES	YES	YES

Intruder Equipage:

RCS	Mode C	ADS-B	TCAS II
L	NO	YES	YES

(N3GC)





(slant range between two IPs ~ 10.8nm;
slant range @ maneuvering point ~ 5.8nm)

Lateral Offset = 0.4 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 1500 ft

Scenario(s): #263

Test Objectives (TO)

1. Same as previous scenario (scenario #21) except DAIDALUS is used to provide SS guidance for this scenario.

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts: TBD
3. Data collected: TBD

Test Method

- MANUEVER: No pilot maneuver is expected.
- Aircraft speeds (non-accelerating): Ownship 150 KTAS, Intruder 173 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm, no DAA alerts displayed.
- Climb Rate: Ownship 1000 fpm, Intruder -1500 fpm
- Expected guidance: Intermittent corrected alerts but no warning alert. No TCAS RA is expected.
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

FT4 TEST OBJECTIVES – SC228 Scenario #23 (Conf. 15-K)

Evaluate DAA system and subsystem performance for a vertical closure encounter with a large TCAS/ADS-B intruder (mitigated, high vertical closure rate, <10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

System Under Test: CPDS

Display: *CDTI/VPD*

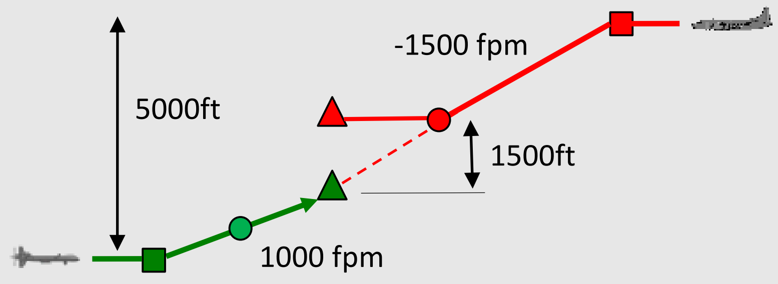
Contributing Sensors (Ownship):

TCAS II	ADS-B	Radar	Tracker
TA/RA	YES	YES	YES

Intruder Equipage:

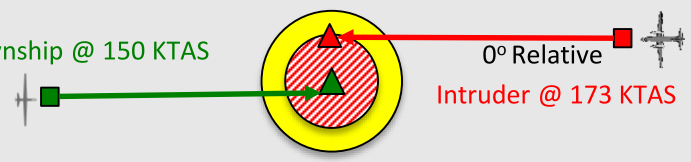
RCS	Mode C	ADS-B	TCAS II
L	NO	YES	YES

(N3GC)



(slant range between two IPs ~ 10.8nm;
slant range @ maneuvering point ~ 5.8nm)

Scenario(s): #264



Lateral Offset = 0.4 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 1500 ft

Test Objectives (TO)

1. Same as previous scenarios (scenarios #21 ad #22) except CPDS is used to provide SS guidance for this scenario.

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts: TBD
3. Data collected: TBD

Test Method

- MANUEVER: No pilot maneuver is expected.
- Aircraft speeds (non-accelerating): Ownship 150 KTAS, Intruder 173 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm, no DAA alerts displayed.
- Climb Rate: Ownship 1000 fpm, Intruder -1500 fpm
- Expected guidance: Intermittent corrected alerts but no warning alert. No TCAS RA is expected.
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

FT4 TEST OBJECTIVES – SC228 Scenario #24 (Conf. 16-A)

Evaluate DAA system and subsystem performance for a turning intruder encounter with a cooperative intruder (mitigated, medium closure rate, <10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

Scenario(s): #265

System Under Test: **Omnibands**

Display: *VSCS*

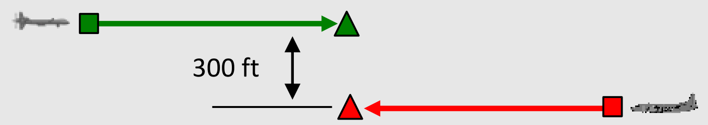
Contributing Sensors (Ownship):

TCAS II	ADS-B	Radar	Tracker
TA/RA	YES	YES	YES

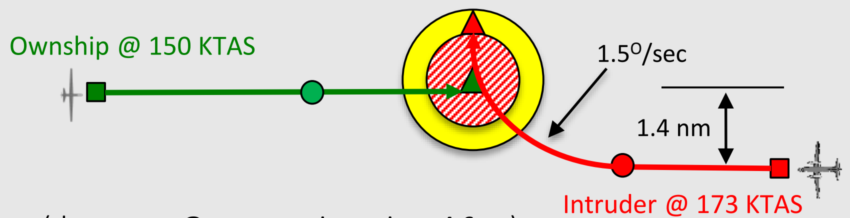
Intruder Equipage:

RCS	Mode C	ADS-B	TCAS II
L	NO	YES	NO

(T-34 for best visibility)



(Virtual offset can be used if 500ft physical separation is required for safety reason)



(slang range @ maneuvering point ~ 4.6nm)

Lateral Offset = 0.4 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 300 ft

Test Objectives (TO)

1. This scenario is designed to test system's ability to deal with turning intruder (initially well clear until it turns) with relatively accurate sensor data.(i.e., ADS-B available for fusion tracker)

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts generated and pilot followed the guidance correctly.
3. Data collected: TBD

Test Method

- MANUEVER: Pilot to manually select and execute 'minimum' maneuver at edge of band (or quantized altitude level). Pilot to follow TCAS RAs if generated.
- Aircraft speeds (non-accelerating): Ownship 150 KTAS, Intruder 173 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm, no DAA alerts displayed.
- Turn Rate: Ownship 0 deg/s, Intruder 1.5 deg/s
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

FT4 TEST OBJECTIVES – SC228 Scenario # 25 (Conf. 16-E)

Evaluate DAA system and subsystem performance for a turning intruder encounter with a medium non-cooperative intruder (mitigated, medium closure rate, <10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

System Under Test: Omnibands

Display: *VSCS*

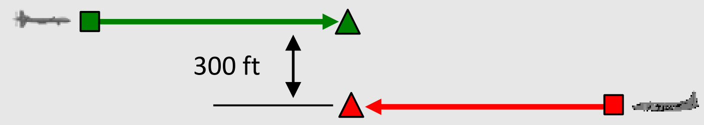
Contributing Sensors (Ownship):

TCAS II	ADS-B	Radar	Tracker
NO	NO	YES	YES

Intruder Equipage:

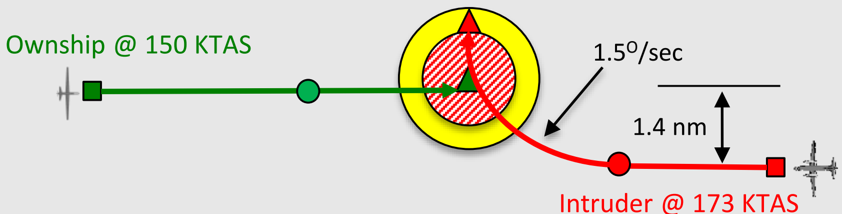
RCS	Mode C	ADS-B	TCAS II
M/L	ON if equipped	ON if equipped	ON if equipped

(T-34 for best visibility)



(Virtual offset can be used if 500ft physical separation is required for safety reason)

Scenario(s): #266



(slang range @ maneuvering point ~ 4.6nm)

Lateral Offset = 0.4 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 300 ft

Test Objectives (TO)

1. Same as previous scenario (scenario #24) except that only radar data is available for DAA processing.

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts generated and pilot followed the guidance correctly.
3. Data collected: TBD

Test Method

- MANUEVER: Pilot to manually select and execute 'minimum' maneuver at edge of band (or quantized altitude level).
- Aircraft speeds (non-accelerating): Ownship 150 KTAS, Intruder 173 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm, no DAA alerts displayed.
- Turn Rate: Ownship 0 deg/s, Intruder 1.5 deg/s
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

FT4 TEST OBJECTIVES – SC228 Scenario #26 (Conf. 16-F)

Evaluate DAA system and subsystem performance for a turning intruder encounter with a cooperative intruder (mitigated, medium closure rate, <10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

System Under Test: DAIDALUS

Display: *Native display*

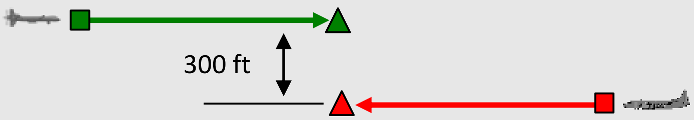
Contributing Sensors (Ownship):

TCAS II	ADS-B	Radar	Tracker
TA/RA	YES	YES	YES

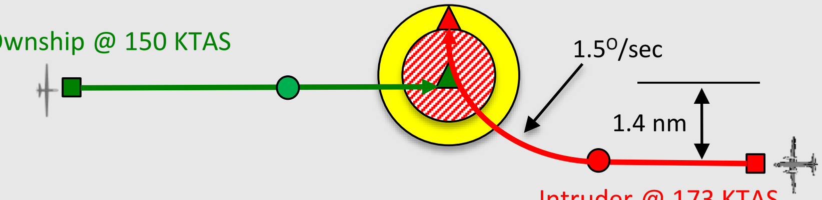
Intruder Equipage:

RCS	Mode C	ADS-B	TCAS II
L	NO	YES	NO

(T-34 for best visibility)



(Virtual offset can be used if 500ft physical separation is required for safety reason)



(slang range @ maneuvering point ~ 4.6nm)

Lateral Offset = 0.4 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 300 ft

Scenario(s): #267

Test Objectives (TO)

1. Same as previous scenario (scenario #24) except that DAIDALUS is used to provide SS guidance.

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts generated and pilot followed the guidance correctly.
3. Data collected: TBD

Test Method

- MANUEVER: Follow SS guidance to remain well clear. Follow TCAS RAs if generated.
- Aircraft speeds (non-accelerating): Ownship 150 KTAS, Intruder 173 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm, no DAA alerts displayed.
- Turn Rate: Ownship 0 deg/s, Intruder 1.5 deg/s
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

FT4 TEST OBJECTIVES – SC228 Scenario #27 (Conf. 16-J)

Evaluate DAA system and subsystem performance for a turning intruder encounter with a medium non-cooperative intruder (mitigated, medium closure rate, <10kft MSL)	MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

System Under Test: DAIDALUS

Display: *Native display*

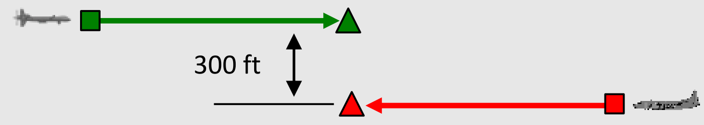
Contributing Sensors (Ownship):

TCAS II	ADS-B	Radar	Tracker
NO	NO	YES	YES

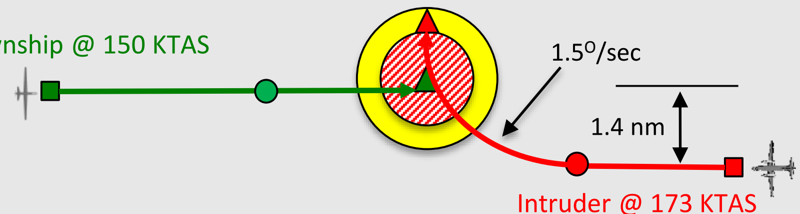
Intruder Equipage:

RCS	Mode C	ADS-B	TCAS II
M/L	ON if equipped	ON if equipped	ON if equipped

(T-34 for best visibility)



(Virtual offset can be used if 500ft physical separation is required for safety reason)



(slang range @ maneuvering point ~ 4.6nm)

Lateral Offset = 0.4 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 300 ft

Scenario(s): #268

Test Objectives (TO)

1. Same as previous scenario (scenario #25) except DAIDALUS is used to provide SS guidance.

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts generated and pilot followed the guidance correctly.
3. Data collected: TBD

Test Method

- MANUEVER: Follow guidance to remain well clear.
- Aircraft speeds (non-accelerating): Ownship 150 KTAS, Intruder 173 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm, no DAA alerts displayed.
- Turn Rate: Ownship 0 deg/s, Intruder 1.5 deg/s
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

FT4 TEST OBJECTIVES – SC228 Scenario #28 (Conf. 16-K)

Evaluate DAA system and subsystem performance for a turning intruder encounter with a cooperative intruder (mitigated, medium closure rate, <10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

System Under Test: CPDS

Display: *CDTI/VPD*

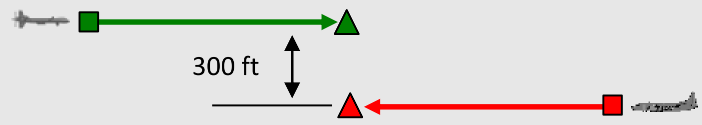
Contributing Sensors (Ownship):

TCAS II	ADS-B	Radar	Tracker
TA/RA	YES	YES	YES

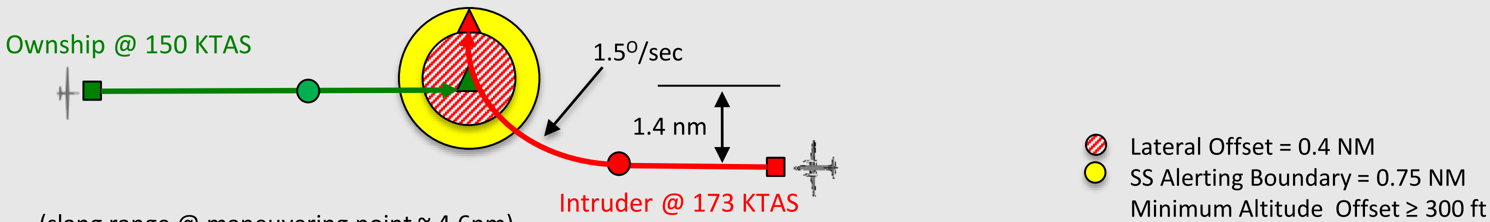
Intruder Equipage:

RCS	Mode C	ADS-B	TCAS II
L	NO	YES	NO

(T-34 for best visibility)



(Virtual offset can be used if 500ft physical separation is required for safety reason)



(slang range @ maneuvering point ~ 4.6nm)

Scenario(s): #269

Test Objectives (TO)

1. Same as previous scenarios (scenarios #24 and #26) except that CPDS is used to provide SS guidance.

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts generated and pilot followed the guidance correctly.
3. Data collected: TBD

Test Method

- MANUEVER: Follow guidance to remain well clear. Follow TCAS RAs if generated.
- Aircraft speeds (non-accelerating): Ownship 150 KTAS, Intruder 173 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm, no DAA alerts displayed.
- Turn Rate: Ownship 0 deg/s, Intruder 1.5 deg/s
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

FT4 TEST OBJECTIVES – SC228 Scenario #29 (Conf. 16-O)

Evaluate DAA system and subsystem performance for a turning intruder encounter with a medium non-cooperative intruder (mitigated, medium closure rate, <10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

Scenario(s): #270

System Under Test: CPDS

Display: *CDTI/VPD*

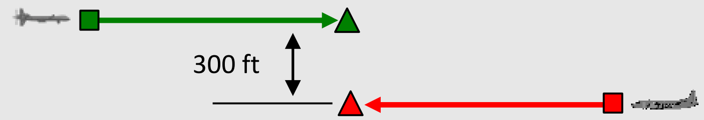
Contributing Sensors (Ownship):

TCAS II	ADS-B	Radar	Tracker
NO	NO	YES	YES

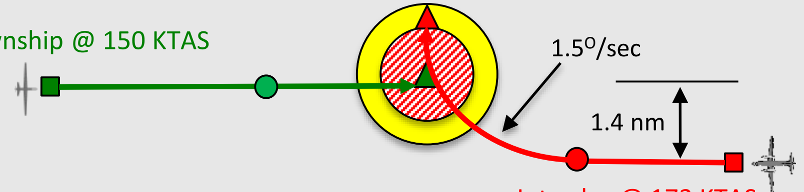
Intruder Equipage:

RCS	Mode C	ADS-B	TCAS II
M/L	ON if equipped	ON if equipped	ON if equipped

(T-34 for best visibility)



(Virtual offset can be used if 500ft physical separation is required for safety reason)



(slang range @ maneuvering point ~ 4.6nm)

Lateral Offset = 0.4 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 300 ft

Test Objectives (TO)

1. Same as previous scenarios (scenarios #25 and #27) except that CPDS is used to provide SS guidance.

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts generated and pilot followed the guidance correctly.
3. Data collected: TBD

Test Method

- MANUEVER: Follow SS guidance to remain well clear.
- Aircraft speeds (non-accelerating): Ownship 150 KTAS, Intruder 173 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm, no DAA alerts displayed.
- Turn Rate: Ownship 0 deg/s, Intruder 1.5 deg/s
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

FT4 TEST OBJECTIVES – SC228 Scenario #30 (Conf. 20-E)

Evaluate DAA system and subsystem performance for a turning intruder encounter with a medium non-cooperative intruder (mitigated, low closure rate, <10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

Scenario(s): #271

System Under Test: **Omnibands**

Display: *VSCS*

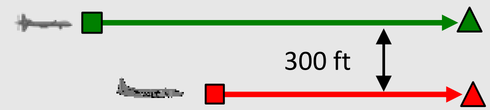
Contributing Sensors (Ownship):

TCAS II	ADS-B	Radar	Tracker
NO	NO	YES	YES

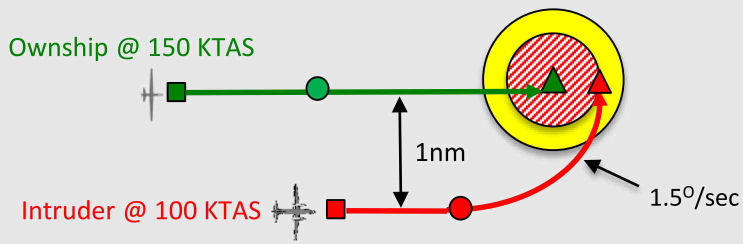
Intruder Equipage:

RCS	Mode C	ADS-B	TCAS II
M/L	ON if equipped	ON if equipped	ON if equipped

(T-34 or TG-14)



(Virtual offset can be used if 500ft physical separation is required for safety reason)



slant range @ maneuvering point ~ 2.2nm
(Key requirement is to maintain closure rate to 40 – 50 KTAS)

Lateral Offset = 0.4 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 300 ft

Test Objectives (TO)

1. This scenario is designed to test system's ability to deal with turning intruder with radar data only.
2. Key requirement for this scenario is to have closure rate in the range of 40 – 50 KTAS. The absolute speeds are less important. For example, 180 vs 130 KTAS would work too.

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts generated and pilot followed the guidance correctly.
3. Data collected: TBD

Test Method

- MANUEVER: Pilot to manually select and execute 'minimum' maneuver at edge of band (or quantized altitude level).
- Aircraft speeds (non-accelerating): Ownship/intruder speeds: 150 /100 KTAS or 180/130 KTAS.
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm, no DAA alerts displayed.
- Turn Rate: Ownship 0 deg/s, Intruder -1.5 deg/s
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

FT4 TEST OBJECTIVES – SC228 Scenario #31 (Conf. 20-J)

Evaluate DAA system and subsystem performance for a turning intruder encounter with a medium non-cooperative intruder (mitigated, low closure rate, <10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

System Under Test: DAIDALUS

Display: *Native display*

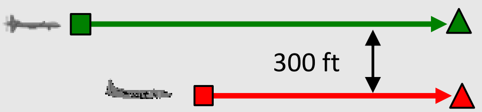
Contributing Sensors (Ownship):

TCAS II	ADS-B	Radar	Tracker
NO	NO	YES	YES

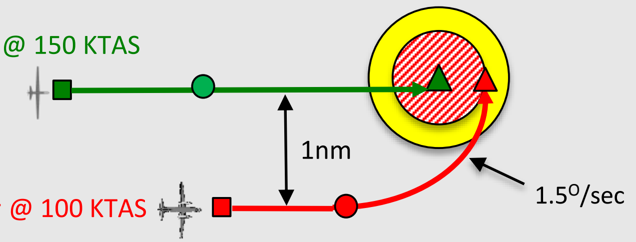
Intruder Equipage:

RCS	Mode C	ADS-B	TCAS II
M/L	ON if equipped	ON if equipped	ON if equipped

(T-34 or TG-14)



(Virtual offset can be used if 500ft physical separation is required for safety reason)



slant range @ maneuvering point ~ 2.2nm
(Key requirement is to maintain closure rate to 40 – 50 KTAS)

Lateral Offset = 0.4 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 300 ft

Scenario(s): #272

Test Objectives (TO)

1. Same as previous scenario (scenario #30) except that DAIDALUS is used to provide SS guidance.

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts generated and pilot followed the guidance correctly.
3. Data collected: TBD

Test Method

- MANUEVER: Follow SS guidance to remain well clear.
- Aircraft speeds (non-accelerating): Ownship 150 KTAS, Intruder 100 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm, no DAA alerts displayed.
- Turn Rate: Ownship 0 deg/s, Intruder -1.5 deg/s
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

FT4 TEST OBJECTIVES – SC228 Scenario #32 (Conf. 20-O)

Evaluate DAA system and subsystem performance for a turning intruder encounter with a medium non-cooperative intruder (mitigated, low closure rate, <10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

Scenario(s): #273

System Under Test: CPDS

Display: *CDTI/VPD*

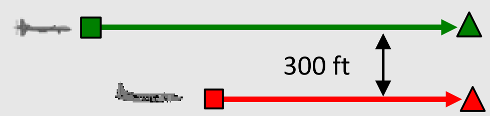
Contributing Sensors (Ownship):

TCAS II	ADS-B	Radar	Tracker
NO	NO	YES	YES

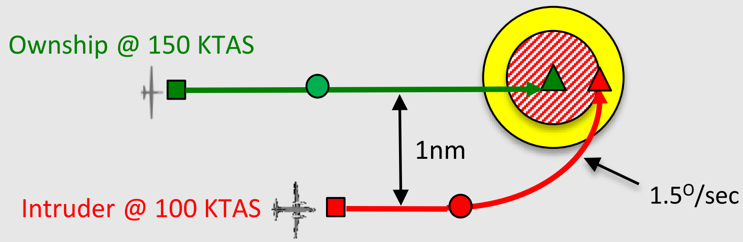
Intruder Equipage:

RCS	Mode C	ADS-B	TCAS II
M/L	ON if equipped	ON if equipped	ON if equipped

(T-34 or TG-14)



(Virtual offset can be used if 500ft physical separation is required for safety reason)



slant range @ maneuvering point ~ 2.2nm
(Key requirement is to maintain closure rate to 40 – 50 KTAS)

Lateral Offset = 0.4 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 300 ft

Test Objectives (TO)

1. Same as previous scenarios (scenarios #30 and #31) except that CPDS is used to provide SS guidance.

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts generated and pilot followed the guidance correctly.
3. Data collected: TBD

Test Method

- MANUEVER: Follow SS guidance to remain well clear.
- Aircraft speeds (non-accelerating): Ownship 150 KTAS, Intruder 100 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm, no DAA alerts displayed.
- Turn Rate: Ownship 0 deg/s, Intruder -1.5 deg/s
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

FT4 TEST OBJECTIVES – SC228 Scenario #33 (Conf. 24-A)

Evaluate DAA system and subsystem performance for a climb into circling intruder encounter with a cooperative intruder (mitigated, medium closure rate, <10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

System Under Test: Omnibands

Display: *VSCS*

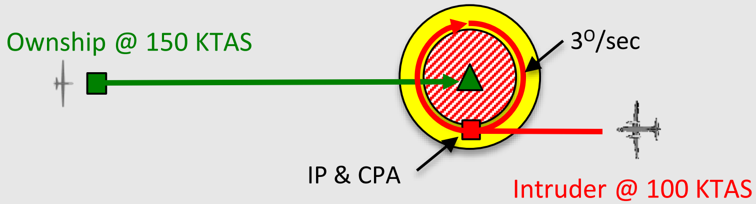
Contributing Sensors (Ownship):

TCAS II	ADS-B	Radar	Tracker
TA/RA	YES	YES	YES

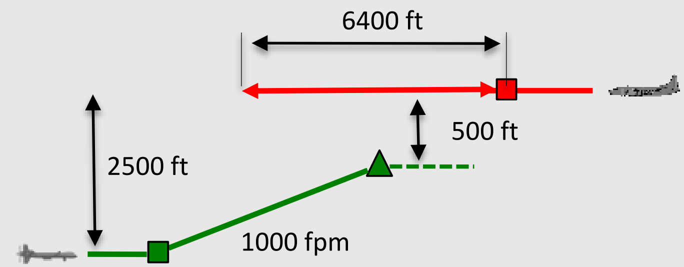
Intruder Equipage:

RCS	Mode C	ADS-B	TCAS II
L/M	NO	YES	NO

(TG-14 preferred due to low speed capability and hence tighter turn)



(Key requirement is to keep loiter radius ~ 3200ft)



(slant range @ IPs ~ 5nm)

Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 500 ft

Scenario(s): #274

Test Objectives (TO)

1. This scenario is designed to test if the DAA system can handle turning intruder with relatively accurate sensor data (i.e., ADS-B data available to fusion tracker).
2. Key requirement to the set-up is to keep turning radius less than 4000ft (3200ft preferred). Intruder speed is not essential. Intruder RCS is not essential (either large or medium will work).

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts generated and pilot followed the guidance correctly.
3. Data collected: TBD

Test Method

- MANUEVER: Pilot to manually select and execute 'minimum' maneuver at edge of band (or quantized altitude level). Pilot to follow TCAS RAs if generated.
- Aircraft speeds (non-accelerating): Ownship 150 KTAS, Intruder 100 KTAS or any to meet the turn radius requirement
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm, no DAA alerts displayed.
- Climb Rate: Ownship 1000 fpm, Intruder 0 fpm
- Turn Rate: Ownship 0 deg/s, Intruder 3 deg/s or any to meet the turn radius requirement
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

FT4 TEST OBJECTIVES – SC228 Scenario #34 (Conf. 24-F)

Evaluate DAA system and subsystem performance for a climb into circling intruder encounter with a cooperative intruder (mitigated, medium closure rate, <10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

System Under Test: DAIDALUS

Display: *Native display*

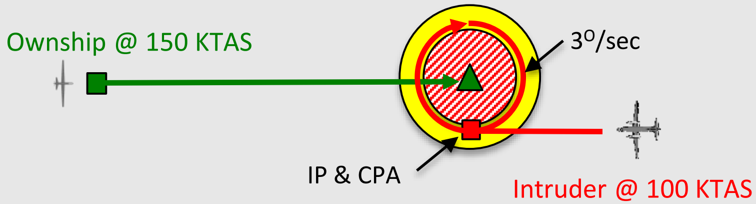
Contributing Sensors (Ownship):

TCAS II	ADS-B	Radar	Tracker
TA/RA	YES	YES	YES

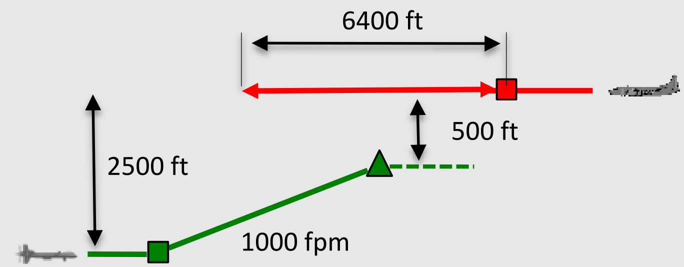
Intruder Equipage:

RCS	Mode C	ADS-B	TCAS II
L	NO	YES	NO

(TG-14 preferred due to low speed capability and hence tighter turn)



(Key requirement is to keep loiter radius ~ 3200ft)



(slant range @ IPs ~ 5nm)

Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 500 ft

Scenario(s): #275

Test Objectives (TO)

1. Same as previous scenario (scenario #33) except DAIDALUS is used to provide SS guidance.

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts generated and pilot followed the guidance correctly.
3. Data collected: TBD

Test Method

- MANUEVER: Pilot to manually select and execute 'minimum' maneuver at edge of band (or quantized altitude level). Pilot to follow TCAS RAs if generated.
- Aircraft speeds (non-accelerating): Ownship 150 KTAS, Intruder 100 KTAS or any to meet the turn radius requirement
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm, no DAA alerts displayed.
- Climb Rate: Ownship 1000 fpm, Intruder 0 fpm
- Turn Rate: Ownship 0 deg/s, Intruder 3 deg/s or any to meet the turn radius requirement
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

FT4 TEST OBJECTIVES – SC228 Scenario #35 (Conf. 24-K)

Evaluate DAA system and subsystem performance for a climb into circling intruder encounter with a cooperative intruder (mitigated, medium closure rate, <10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

System Under Test: **CPDS**

Display: *CDTI/VPD*

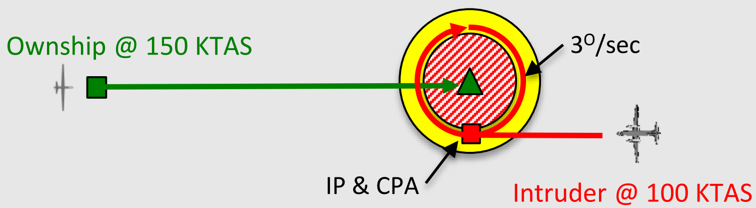
Contributing Sensors (Ownship):

TCAS II	ADS-B	Radar	Tracker
TA/RA	YES	YES	YES

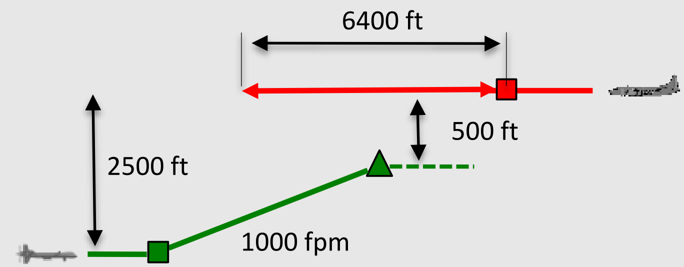
Intruder Equipage:

RCS	Mode C	ADS-B	TCAS II
L	NO	YES	NO

(TG-14 preferred due to low speed capability and hence tighter turn)



(Key requirement is to keep loiter radius ~ 3200ft)



(slant range @ IPs ~ 5nm)

Lateral Offset = 0.5 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 500 ft

Scenario(s): #276

Test Objectives (TO)

1. Same as previous scenarios (scenarios #33 and #34) except that CPDS is used to provide SS guidance.

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts generated and pilot followed the guidance correctly.
3. Data collected: TBD

Test Method

- MANUEVER: Pilot to manually select and execute 'minimum' maneuver at edge of band (or quantized altitude level). Pilot to follow TCAS RAs if generated.
- Aircraft speeds (non-accelerating): Ownship 150 KTAS, Intruder 100 KTAS or any to meet the turn radius requirement
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm, no DAA alerts displayed.
- Climb Rate: Ownship 1000 fpm, Intruder 0 fpm
- Turn Rate: Ownship 0 deg/s, Intruder 3 deg/s or any to meet the turn radius requirement
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

FT4 TEST OBJECTIVES – SC228 Scenario #36 (Conf. 25-A)

Evaluate DAA system and subsystem performance for climb & turn into a level large TCAS/ADS-B intruder (mitigated, medium closure rate, <10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

Scenario(s): #277

System Under Test: **Omnibands**

Display: *VSCS*

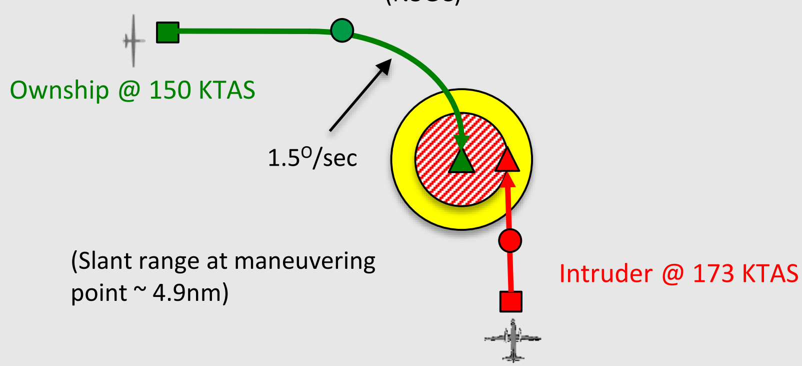
Contributing Sensors (Ownship):

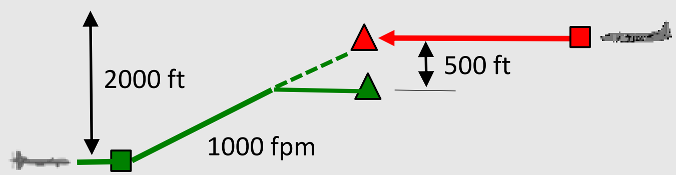
TCAS II	ADS-B	Radar	Tracker
TA/RA	YES	YES	YES

Intruder Equipage:

RCS	Mode C	ADS-B	TCAS II
L	NO	YES	YES

(N3GC)





(Slant range at IPs ~ 7.6nm)

Lateral Offset = 0.4 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 500 ft

Test Objectives (TO)

1. This scenario is designed to test if the DAA system can handle ownship turning.

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts generated and pilot followed the guidance correctly.
3. Data collected: TBD

Test Method

- MANUEVER: Pilot to manually select and execute 'minimum' maneuver at edge of band (or quantized altitude level). Pilot to follow TCAS RAs if generated.
- Aircraft speeds Ownship 150 KTAS, Intruder 173 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm, no DAA alerts displayed.
- Climb and turn Rates: Ownship 1000 fpm and 1.5 deg/s, Intruder 0 fpm and 0 deg/s
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

FT4 TEST OBJECTIVES – SC228 Scenario #37 (Conf. 25-F)

Evaluate DAA system and subsystem performance for climb & turn into a level large TCAS/ADS-B intruder (mitigated, medium closure rate, <10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

System Under Test: DAIDALUS

Display: *Native display*

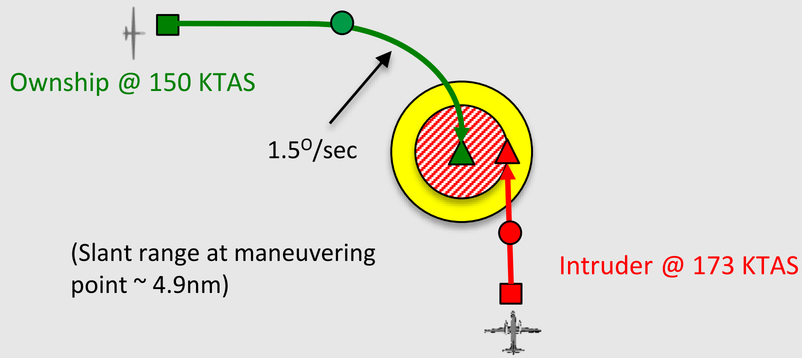
Contributing Sensors (Ownship):

TCAS II	ADS-B	Radar	Tracker
TA/RA	YES	YES	YES

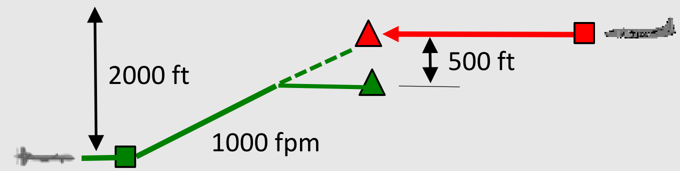
Intruder Equipage:

RCS	Mode C	ADS-B	TCAS II
L	NO	YES	YES

(N3GC)



(Slant range at maneuvering point ~ 4.9nm)



(Slant range at IPs ~ 7.6nm)

Lateral Offset = 0.4 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 500 ft

Scenario(s): #278

Test Objectives (TO)

1. Same as previous scenario (scenario #36) except that DAIDALUS is used to provide SS guidance..

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts generated and pilot followed the guidance correctly.
3. Data collected: TBD

Test Method

- MANUEVER: Follow SS guidance to remain well clear. Follow TCAS RAs if generated.
- Aircraft speeds (non-accelerating): Ownship 150 KTAS, Intruder 173 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm, no DAA alerts displayed.
- Climb and turn Rates: Ownship 1000 fpm and 1.5 deg/s, Intruder 0 fpm and 0 deg/s
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

FT4 TEST OBJECTIVES – SC228 Scenario #38 (Conf. 25-K)

Evaluate DAA system and subsystem performance for climb & turn into a level large TCAS/ADS-B intruder (mitigated, medium closure rate, <10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

Scenario(s): #279

System Under Test: CPDS

Display: *CDTI/VPD*

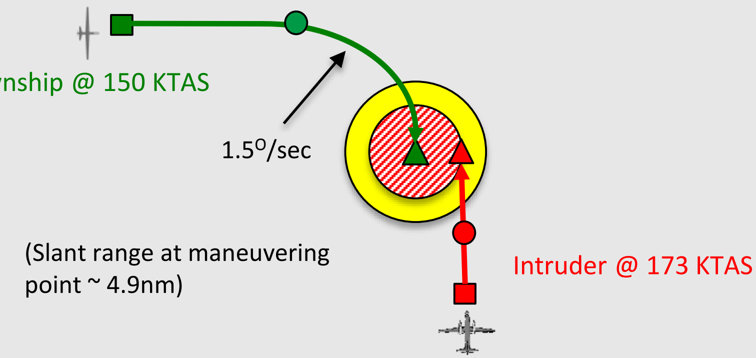
Contributing Sensors (Ownship):

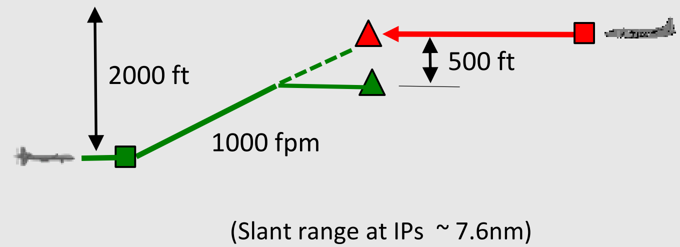
TCAS II	ADS-B	Radar	Tracker
TA/RA	YES	YES	YES

Intruder Equipage:

RCS	Mode C	ADS-B	TCAS II
L	NO	YES	YES

(N3GC)





Lateral Offset = 0.4 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 500 ft

Test Objectives (TO)

1. Same as previous scenarios (scenarios #36 and #37) except that CPDS is used to provide SS guidance.

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts generated and pilot followed the guidance correctly.
3. Data collected: TBD

Test Method

- MANUEVER: Follow guidance to remain well clear. Follow TCAS RAs if generated.
- Aircraft speeds (non-accelerating): Ownship 150 KTAS, Intruder 173 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm, no DAA alerts displayed.
- Climb and turn Rates: Ownship 1000 fpm and 1.5 deg/s, Intruder 0 fpm and 0 deg/s
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

FT4 TEST OBJECTIVES – SC228 Scenario #39 (Conf. 27-A)

Evaluate DAA system and subsystem performance for a vertical closure encounter with a large TCAS/ADS-B intruder (mitigated, moderate vertical closure rate, <10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

Scenario(s): #280

System Under Test: Omnibands

Display: *VSCS*

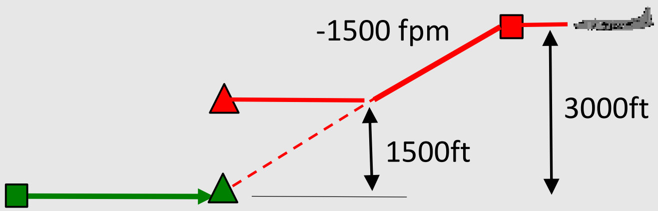
Contributing Sensors (Ownship):

TCAS II	ADS-B	Radar	Tracker
TA/RA	YES	YES	YES

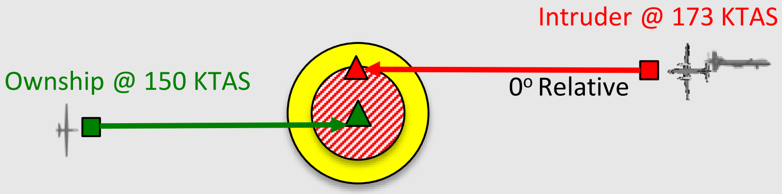
Intruder Equipage:

RCS	Mode C	ADS-B	TCAS II
L	NO	YES	YES

(N3GC)



(slant range between two IPs ~ 10.8nm)



Lateral Offset = 0.4 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 1500 ft

Test Objectives (TO)

1. This scenario is designed to test the chance of false alert under moderate vertical closure rate condition given the MOPS alerting threshold.

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts: TBD
3. Data collected: TBD

Test Method

- MANUEVER: No pilot maneuver is expected.
- Aircraft speeds (non-accelerating): Ownship 150 KTAS, Intruder 173 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm, no DAA alerts displayed.
- Climb Rate: Ownship 0 fpm, Intruder -1500 fpm
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: Medium.

FT4 TEST OBJECTIVES – SC228 Scenario #40 (Conf. 27-F)

Evaluate DAA system and subsystem performance for a vertical closure encounter with a large TCAS/ADS-B intruder (mitigated, moderate vertical closure rate, <10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

System Under Test: DAIDALUS

Display: *Native display*

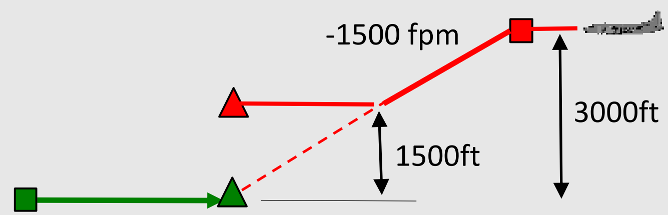
Contributing Sensors (Ownship):

TCAS II	ADS-B	Radar	Tracker
TA/RA	YES	YES	YES

Intruder Equipage:

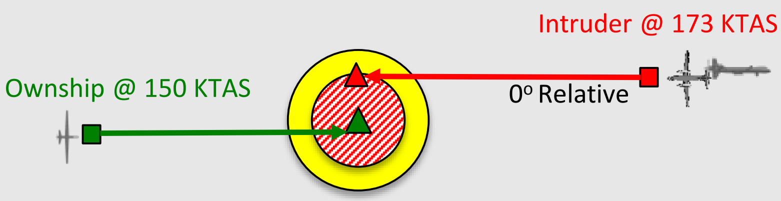
RCS	Mode C	ADS-B	TCAS II
L	NO	YES	YES

(N3GC)



(slant range between two IPs ~ 10.8nm)

Scenario(s): #281



Lateral Offset = 0.4 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 1500 ft

Test Objectives (TO)

1. Same as previous scenario (scenario #39) except that DAIDALUS is used to provide SS guidance for this scenario.

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts: TBD
3. Data collected: TBD

Test Method

- MANUEVER: No pilot maneuver is expected.
- Aircraft speeds (non-accelerating): Ownship 150 KTAS, Intruder 173 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm, no DAA alerts displayed.
- Climb Rate: Ownship 0 fpm, Intruder -1500 fpm
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: Medium.

FT4 TEST OBJECTIVES – SC228 Scenario #41 (Conf. 27-K)

Evaluate DAA system and subsystem performance for a vertical closure encounter with a large TCAS/ADS-B intruder (mitigated, moderate vertical closure rate, <10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

System Under Test: CPDS

Display: *CDTI/VPD*

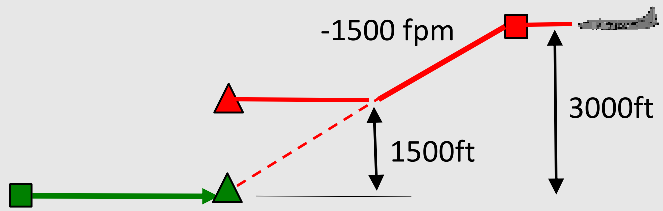
Contributing Sensors (Ownship):

TCAS II	ADS-B	Radar	Tracker
TA/RA	YES	YES	YES

Intruder Equipage:

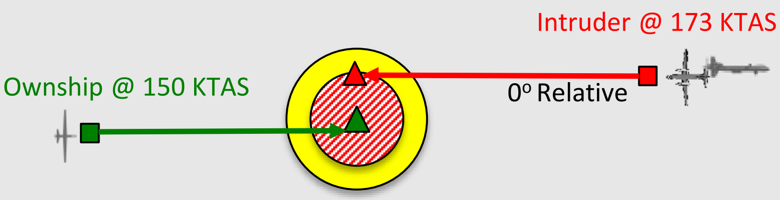
RCS	Mode C	ADS-B	TCAS II
L	NO	YES	YES

(N3GC)



(slant range between two IPs ~ 10.8nm)

Scenario(s): #282



Lateral Offset = 0.4 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 1500 ft

Test Objectives (TO)

1. Same as previous scenarios (scenarios #39 and #40) except that CPDS is used to provide SS guidance for this scenario.

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts: TBD
3. Data collected: TBD

Test Method

- MANUEVER: No pilot maneuver is expected.
- Aircraft speeds (non-accelerating): Ownship 150 KTAS, Intruder 173 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm, no DAA alerts displayed.
- Climb Rate: Ownship 0 fpm, Intruder -1500 fpm
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: Medium.

Multiple Intruders

FT4 TEST OBJECTIVES – SC228 Scenario #42 (Conf. 31-P)

Evaluate DAA system and subsystem performance for a multiple intruder encounter: sandwiched horizontally by two intruders (mitigated, <10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

System Under Test: **Omnibands**

Display: *VSCS*

Contributing Sensors (Ownship):

TCAS II	ADS-B	Radar	Tracker
TA/RA	YES	YES	YES

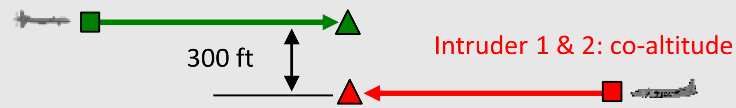
Intruder 1 Equipage:

RCS	Mode C	ADS-B	TCAS II
L/M	NO	YES	YES

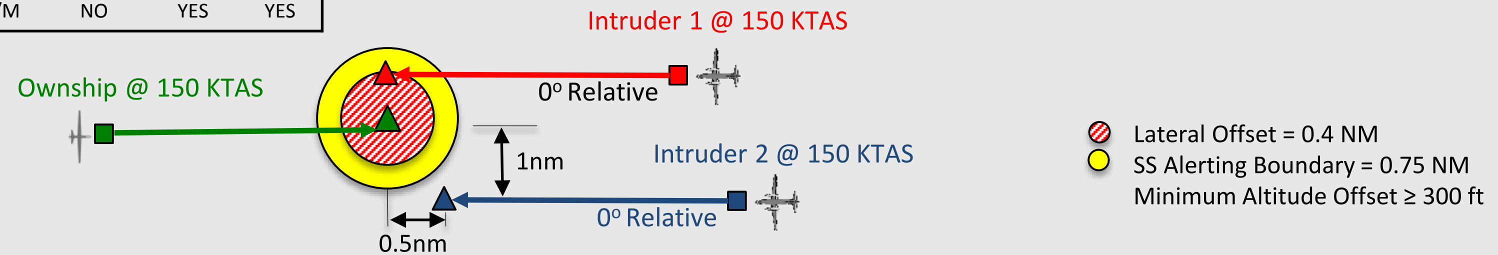
(Note: TCAS I is OK if two TCAS II intruders are not available)

Intruder 2 Equipage:

RCS	Mode C	ADS-B	TCAS II
L/M	NO	YES	YES



Scenario(s): #283



Test Objectives (TO)

1. This scenario is designed to test if the DAA system can deal with multi-threats with relatively accurate sensor data (i.e., ADS-B data is available to fusion tracker) – one threat (intruder 1) requires SS maneuver while the other (intruder 2) is near-by such that action space for SS maneuver is constrained.

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts generated and pilot followed the guidance correctly.
3. Data collected: TBD

Test Method

- MANUEVER: Pilot to follow DAA guidance. Pilot to follow TCAS RAs if generated.
- Aircraft speeds (non-accelerating): Ownship 150 KTAS, Both intruders 150 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm., no DAA alerts displayed.
- Climb/Roll/Pitch Rates: 0/0/0
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance.
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

FT4 TEST OBJECTIVES – SC228 Scenario #43 (Conf. 31-Q)

Evaluate DAA system and subsystem performance for a multiple intruder encounter: sandwiched horizontally by two intruders (mitigated, <10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

System Under Test: **Omnibands**

Display: *VSCS*

Contributing Sensors (Ownship):

TCAS II	ADS-B	Radar	Tracker
TA/RA	YES	YES	YES

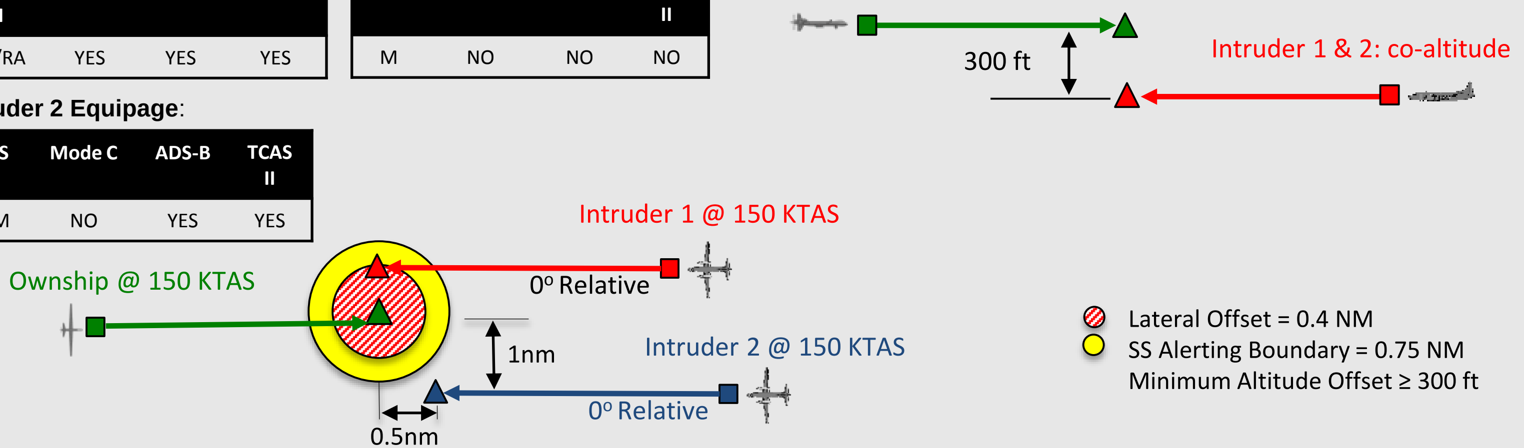
Intruder 1 Equipage:

RCS	Mode C	ADS-B	TCAS II
M	NO	NO	NO

Intruder 2 Equipage:

RCS	Mode C	ADS-B	TCAS II
L/M	NO	YES	YES

Scenario(s): #284



Test Objectives (TO)

1. Same as previous scenario (scenario #42) except intruder 1 is non-cooperative (i.e., only radar data is available for DAA processing), thus making it more challenging.

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts generated and pilot followed the guidance correctly.
3. Data collected: TBD

Test Method

- MANUEVER: Pilot to follow DAA guidance.. Pilot to follow TCAS RAs if generated.
- Aircraft speeds (non-accelerating): Ownship 150 KTAS, Both intruders 150 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm., no DAA alerts displayed.
- Climb/Roll/Pitch Rates: 0/0/0
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance.
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

FT4 TEST OBJECTIVES – SC228 Scenario #44 (Conf. 31-T)

Evaluate DAA system and subsystem performance for a multiple intruder encounter: sandwiched horizontally by two intruders (mitigated, <10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

System Under Test: DAIDALUS

Display: *Native display*

Contributing Sensors (Ownship):

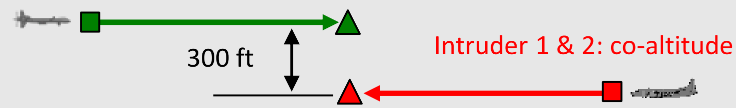
TCAS II	ADS-B	Radar	Tracker
TA/RA	YES	YES	YES

Intruder 1 Equipage:

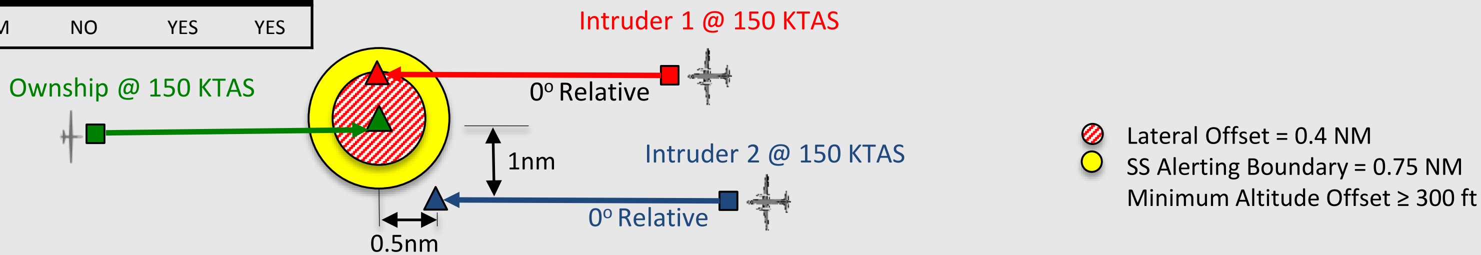
RCS	Mode C	ADS-B	TCAS II
M	NO	NO	NO

Intruder 2 Equipage:

RCS	Mode C	ADS-B	TCAS II
L/M	NO	YES	YES



Scenario(s): #285



Test Objectives (TO)

1. Same as previous scenario (scenario #43) except that DAIDALUS is used to provide SS guidance for this scenario.

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts generated and pilot followed the guidance correctly.
3. Data collected: TBD

Test Method

- MANUEVER: Pilot to follow DAA guidance.. Pilot to follow TCAS RAs if generated.
- Aircraft speeds (non-accelerating): Ownship 150 KTAS, Both intruders 150 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm., no DAA alerts displayed.
- Climb/Roll/Pitch Rates: 0/0/0
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance.
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

FT4 TEST OBJECTIVES – SC228 Scenario #45 (Conf. 32-T)

Evaluate DAA system and subsystem performance for a multiple intruder encounter: sandwiched vertically by two intruders (mitigated, <10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

System Under Test: DAIDALUS

Display: *Native display*

Contributing Sensors (Ownship):

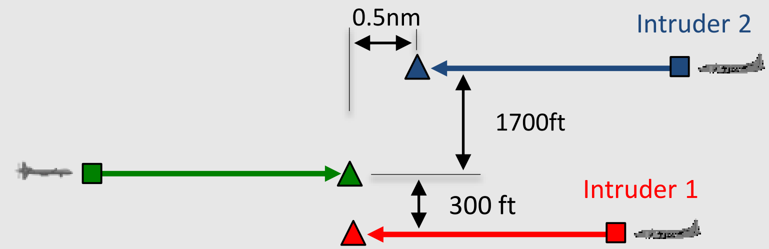
TCAS II	ADS-B	Radar	Tracker
TA/RA	YES	YES	YES

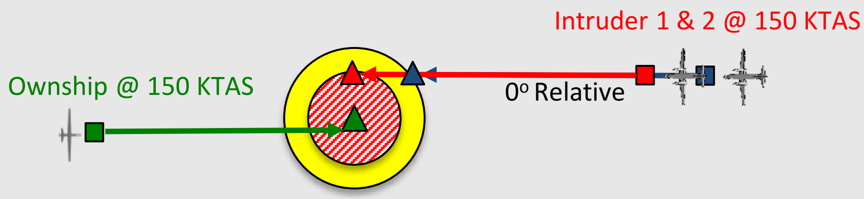
Intruder 1 Equipage:

RCS	Mode C	ADS-B	TCAS II
M	NO	NO	NO

Intruder 2 Equipage:

RCS	Mode C	ADS-B	TCAS II
L/M	NO	YES	YES





Lateral Offset = 0.4 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 300 ft

Scenario(s): #286

Test Objectives (TO)

1. This scenario is designed to test if the DAA system can deal with multi-threats – one threat (intruder 1) requires SS maneuver while the other (intruder 2) is near-by such that action space for SS maneuver is constrained.

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts generated and pilot followed the guidance correctly.
3. Data collected: TBD

Test Method

- MANUEVER: Pilot to follow DAA guidance.. Pilot to follow TCAS RAs if generated.
- Aircraft speeds (non-accelerating): Ownship 150 KTAS, Both intruders 150 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm., no DAA alerts displayed.
- Climb/Roll/Pitch Rates: 0/0/0
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance.
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

FT4 TEST OBJECTIVES – SC228 Scenario #46 (Conf. 32-V)

Evaluate DAA system and subsystem performance for a multiple intruder encounter: sandwiched vertically by two intruders (mitigated, <10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

System Under Test: CPDS

Display: *CDTI/VPD*

Contributing Sensors (Ownship):

TCAS II	ADS-B	Radar	Tracker
TA/RA	YES	YES	YES

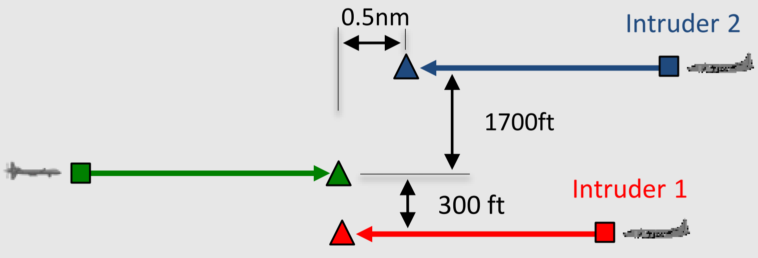
Intruder 1 Equipage:

RCS	Mode C	ADS-B	TCAS II
L/M	NO	YES	YES

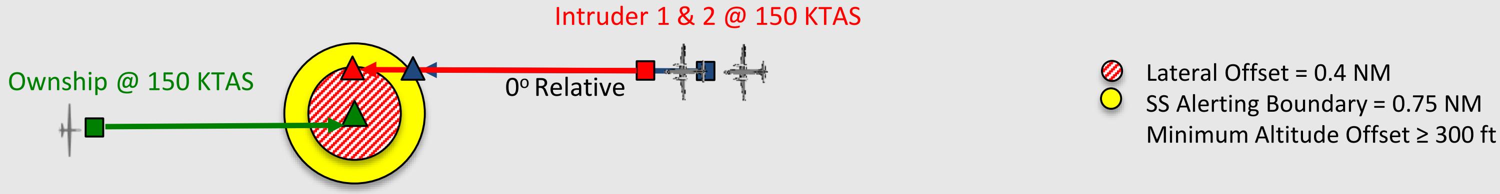
(Note: TCAS I is OK if two TCAS II intruders are not available)

Intruder 2 Equipage:

RCS	Mode C	ADS-B	TCAS II
L/M	NO	YES	YES



Scenario(s): #287



Test Objectives (TO)

1. Same as previous scenario (scenario #45) except that: 1) both intruders are cooperative with ADS-B and TCAS II and 2) CPDS is used to provide SS guidance.

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts generated and pilot followed the guidance correctly.
3. Data collected: TBD

Test Method

- MANUEVER: Pilot to follow DAA guidance. Pilot to follow TCAS RAs if generated.
- Aircraft speeds (non-accelerating): Ownship 150 KTAS, Both intruders 150 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm., no DAA alerts displayed.
- Climb/Roll/Pitch Rates: 0/0/0
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance.
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

FT4 TEST OBJECTIVES – SC228 Scenario #47 (Conf. 32-W)

Evaluate DAA system and subsystem performance for a multiple intruder encounter: sandwiched vertically by two intruders (mitigated, <10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

System Under Test: CPDS

Display: *CDTI/VPD*

Contributing Sensors (Ownship):

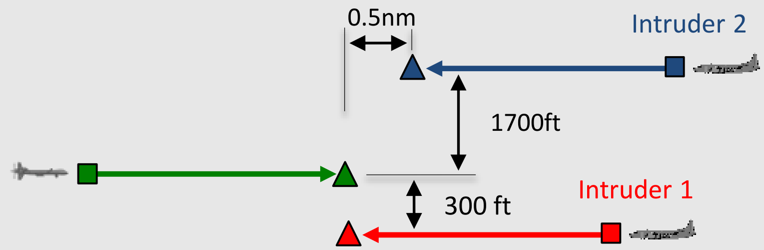
TCAS II	ADS-B	Radar	Tracker
TA/RA	YES	YES	YES

Intruder 1 Equipage:

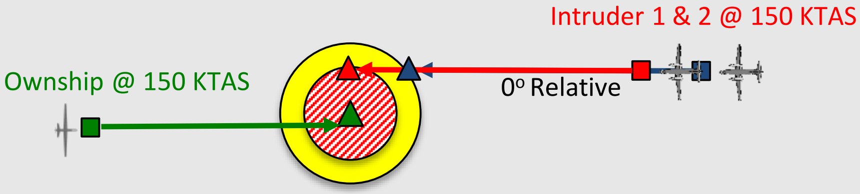
RCS	Mode C	ADS-B	TCAS II
M	NO	NO	NO

Intruder 2 Equipage:

RCS	Mode C	ADS-B	TCAS II
L/M	NO	YES	YES



Scenario(s): #288



Lateral Offset = 0.4 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 300 ft

Test Objectives (TO)

1. Same as previous scenario (scenario #45) except that CPDS is used to provide SS guidance for this scenario.

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts generated and pilot followed the guidance correctly.
3. Data collected: TBD

Test Method

- MANUEVER: Pilot to follow DAA guidance.. Pilot to follow TCAS RAs if generated.
- Aircraft speeds (non-accelerating): Ownship 150 KTAS, Both intruders 150 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm., no DAA alerts displayed.
- Climb/Roll/Pitch Rates: 0/0/0
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance.
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

FT4 TEST OBJECTIVES – SC228 Scenario #48 (Conf. 35-Q)

Evaluate DAA system and subsystem performance for a multiple intruder encounter: sandwiched horizontally & vertically by two intruders (mitigated, <10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

Scenario(s): #289

System Under Test: **Omnibands**

Display: *VSCS*

Contributing Sensors (Ownship):

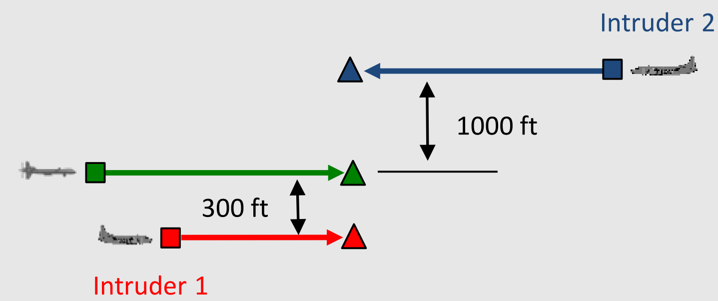
TCAS II	ADS-B	Radar	Tracker
TA/RA	YES	YES	YES

Intruder 1 Equipage:

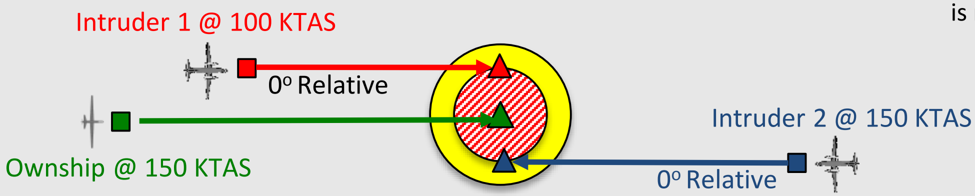
RCS	Mode C	ADS-B	TCAS II
M	NO	NO	NO

Intruder 2 Equipage:

RCS	Mode C	ADS-B	TCAS II
L/M	NO	YES	YES



(Virtual offset can be used if 500ft physical separation is required for intruder 1 for safety reason)



Lateral Offset = 0.4 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 300 ft

Test Objectives (TO)

1. This scenario is designed to test if the DAA system can deal with multi-threats – one threat (intruder 1) requires SS maneuver while the other (intruder 2) is near-by such that action space for SS maneuver is constrained.
2. Key requirement for the set-up with respect to intruder 1 is to have closure rate in the range of 40 – 50 KTAS. The absolute speeds are less important (e.g., 180 vs. 130 KTAS would work as well).

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts generated and pilot followed the guidance correctly.
3. Data collected: TBD

Test Method

- MANUEVER: Pilot to follow DAA guidance.. Pilot to follow TCAS RAs if generated.
- Aircraft speeds (non-accelerating): Ownship/intruder1 150/100 KTAS or 180/130 KTAS, Intruder2 150 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm., no DAA alerts displayed.
- Climb/Roll/Pitch Rates: 0/0/0
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance.
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

FT4 TEST OBJECTIVES – SC228 Scenario #49 (Conf. 35-T)

Evaluate DAA system and subsystem performance for a multiple intruder encounter: sandwiched horizontally & vertically by two intruders (mitigated, <10kft MSL)	MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

System Under Test: DAIDULUS

Display: *Native display*

Contributing Sensors (Ownship):

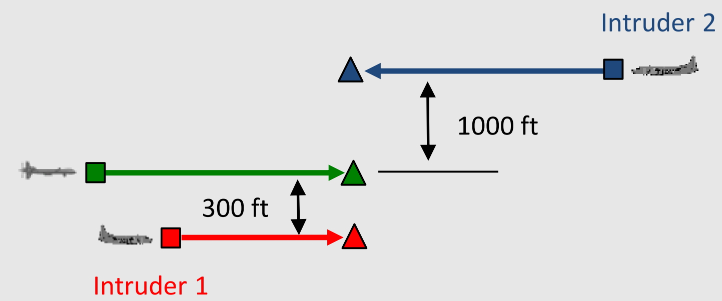
TCAS II	ADS-B	Radar	Tracker
TA/RA	YES	YES	YES

Intruder 1 Equipage:

RCS	Mode C	ADS-B	TCAS II
M	NO	NO	NO

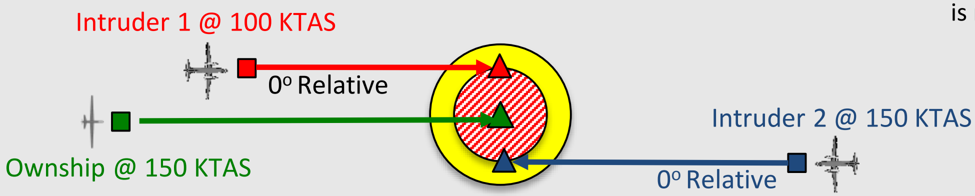
Intruder 2 Equipage:

RCS	Mode C	ADS-B	TCAS II
L/M	NO	YES	YES



(Virtual offset can be used if 500ft physical separation is required for intruder 1 for safety reason)

Scenario(s): #290



Lateral Offset = 0.4 NM
SS Alerting Boundary = 0.75 NM
Minimum Altitude Offset ≥ 300 ft

Test Objectives (TO)

1. Same as previous scenario (scenario #48) except that DAIDALUS is used to provide SS guidance for this scenario.

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts generated and pilot followed the guidance correctly.
3. Data collected: TBD

Test Method

- MANUEVER: Pilot to follow DAA guidance.. Pilot to follow TCAS RAs if generated.
- Aircraft speeds (non-accelerating): Ownship/intruder1 150/100 KTAS or 180/130 KTAS, Intruder2 150 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm., no DAA alerts displayed.
- Climb/Roll/Pitch Rates: 0/0/0
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance.
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

FT4 TEST OBJECTIVES – SC228 Scenario #50 (Conf. 35-V)

Evaluate DAA system and subsystem performance for a multiple intruder encounter: sandwiched horizontally & vertically by two intruders (mitigated, <10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

System Under Test: CPDS

Display: *CDTI/VPD*

Contributing Sensors (Ownship):

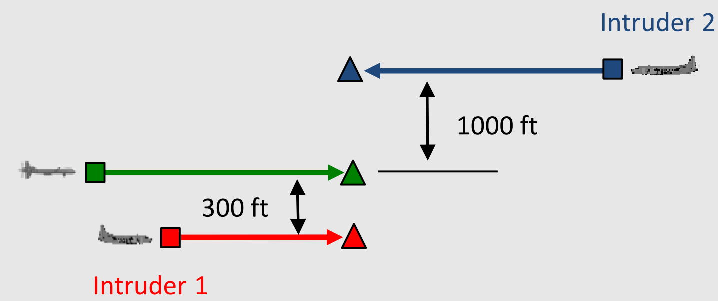
TCAS II	ADS-B	Radar	Tracker
TA/RA	YES	YES	YES

Intruder 1 Equipage:

RCS	Mode C	ADS-B	TCAS II
L/M	NO	YES	NO

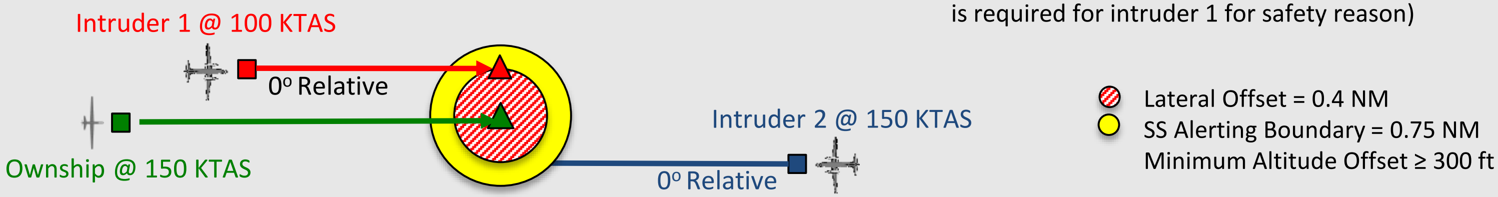
Intruder 2 Equipage:

RCS	Mode C	ADS-B	TCAS II
L/M	NO	YES	YES



(Virtual offset can be used if 500ft physical separation is required for intruder 1 for safety reason)

Scenario(s): #291



Test Objectives (TO)

1. Same as previous scenario (scenario #49) except that: 1) CPDS is used to provide SS guidance for this scenario and 2) both intruders are cooperative with ADS-B and TCAS II.

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts generated and pilot followed the guidance correctly.
3. Data collected: TBD

Test Method

- MANUEVER: Pilot to follow DAA guidance.. Pilot to follow TCAS RAs if generated.
- Aircraft speeds (non-accelerating): Ownship/intruder1 150/100 KTAS or 180/130 KTAS, Intruder2 150 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm., no DAA alerts displayed.
- Climb/Roll/Pitch Rates: 0/0/0
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance.
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

FT4 TEST OBJECTIVES – SC228 Scenario #51 (Conf. 35-W)

Evaluate DAA system and subsystem performance for a multiple intruder encounter: sandwiched horizontally & vertically by two intruders (mitigated, <10kft MSL)

MOPS Sections 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and applicable appendices.

Configuration

System Under Test: CPDS

Display: *CDTI/VPD*

Contributing Sensors (Ownship):

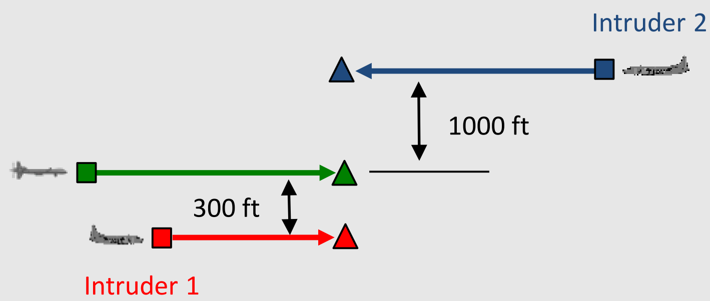
TCAS II	ADS-B	Radar	Tracker
TA/RA	YES	YES	YES

Intruder 1 Equipage:

RCS	Mode C	ADS-B	TCAS II
M	NO	NO	NO

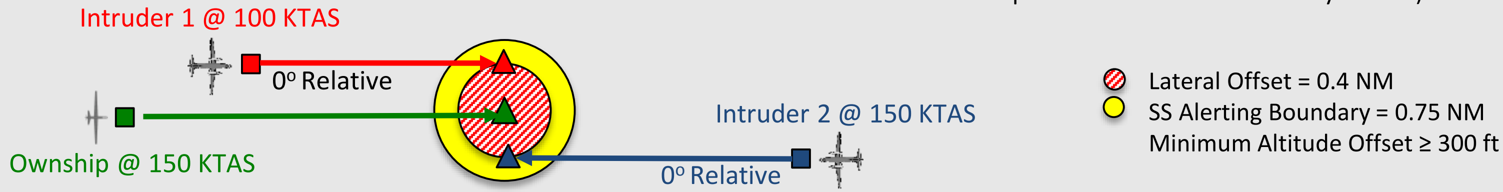
Intruder 2 Equipage:

RCS	Mode C	ADS-B	TCAS II
L/M	NO	YES	YES



(Virtual offset can be used if 500ft physical separation is required for intruder 1 for safety reason)

Scenario(s): #292



Test Objectives (TO)

1. Same as previous scenario (scenario #50) except that intruder 1 is non-cooperative (i.e., radar data only), thus making it more challenging.

Success Criteria (retest if criteria not met)

1. Scenario executed as specified.
2. DAA alerts generated and pilot followed the guidance correctly.
3. Data collected: TBD

Test Method

- MANUEVER: Pilot to follow DAA guidance.. Pilot to follow TCAS RAs if generated.
- Aircraft speeds (non-accelerating): Ownship/intruder1 150/100 KTAS or 180/130 KTAS, Intruder2 150 KTAS
- Encounter Length: 2 min (IP to CPA)
- Stable Conditions: stable at the IP (2 minutes prior to CPA)
- Test Termination Criteria: targets diverging, range > 0.75 nm., no DAA alerts displayed.
- Climb/Roll/Pitch Rates: 0/0/0
- Tolerance: ± 8 sec, ± 5 kts at IP crossing.

Evaluation Criteria (Post-test analysis to determine if test objectives are met)

1. Sensor provides data with expected performance.
2. Sensor data processing and tracking provides integrated track with expected performance.
3. UAS pilot receives DAA corrective alert with associated guidance.
4. DAA alert(s) and guidance are removed once ownship is clear of threat.
5. CPA prediction accuracy sufficient for DAA function.

Additional Information

Priority: High.

Appendix G FT4 Flight Test Asset Matrix

FT4 Test Aircraft Equipage & Parametric Worksheet											
Sensor & Surveillance Worksheet	Sensor Equipage (DAA)	ADS-B/TCAS II Hybrid Alerting Transition (Near Threat)	ADS-B Capability (ES 2Hz)	*ADS-B Insitu Performance (14 CFR 91.227)	Transponder Altitude Data	Airspeed Req (KGS)	Altitude Req (ft)	¨Airspeed Envelop (KIAS)	¨Climb/Descent Max Rates (FPM)	Aircraft Category	Notes
Ownship Aircraft											
NASA870 (Pred B)	BAE AN/DPX-7 ADS-B/Mode S HW TPA-100B TCAS II (ver7.1) GA-ASI EDM DRR JAVAD GNSS SIGMA-G2T DGPS	>60 sec/4500 ft = ADS-B <60 sec/4500 ft = TCAS	In/Out (1090 MHz)	NACp - 11 NIC - x NACv - 4 SIL - x SDA - x	100 ft	>10K 150, 160, 180, 200 <10K 120, 150, 160, 180	1,000 ft AGL to 18,000 ft MSL	85-190	±1,000	N/A	GPS L1/L2/L2C/L5; Hybrid surveillance rate once per minute increased to once every 10 sec (>60 sec), then once per second (<60 sec) to near threat; Airspeed window at 15'K MSL is 85-190 KIAS.
Intruder Aircraft											
N3GC (C90)	HW TRA-100B ADS-B/Mode S HW TPA-100B TCAS II (ver7.1) HW CMA-3012 GNSSU Novatel ProPak6 DGPS	N/A	In/Out (1090 MHz)	NACp - 7 NIC - 8 NACv - 1 SIL - 2 SDA - 2	25 ft	140, 150, 160, 180	1,000 ft AGL to 18,000 ft MSL	110-180	+700 -3,000	Medium Speed Large RCS	GPS L1/L2; TCAS recording capable; Novatel ProPak6 truth system to be procured, shipped to HW (Seattle) and installed. Requires minimum delivery 2 weeks in advance of flight test date. Airspeed window at 15'K MSL is 110-180 KIAS.
NASA865 (T-34C)	Garmin GTX-330ES ADS-B/Mode S Skywatch TCAS I Garmin GNS-430W GPS Ashtech Z-12 DGPS	N/A	Out (1090 MHz)	NACp - 10 NIC - 9 NACv - 2 SIL - 3 SDA - 2	100 ft	140, 150, 160, 180	1,000 ft AGL to 18,000 ft MSL	85-175	+1,000 -3,000	Medium Speed Medium RCS	GPS L1/L2; Airspeed window at 15'K MSL is 85-175 KIAS; ADS-B parameter data (reporting out) from flight data collected during FT3.
NASA7 (B200)	Garmin GTX-330ES ADS-B/Mode S Skywatch TCAS I Garmin GNS-430W GPS	N/A	Out (1090 MHz)	NACp - 9 NIC - 8 NACv - x SIL - x SDA - x NOT AVAILABLE FOR FT4	100 ft	140, 150, 160, 180, 210, 250	1,000 ft AGL to 18,000 ft MSL	140-250	+1,500 -3,000	Medium Speed Large RCS	NASA7NA is an FAA registered aircraft, therefore, modifications require a FAA inspection and approval which may prevent availability of a DGPS system. Airspeed window at 15'K MSL is 140-250 KIAS. NASA7 will serve as a backup intruder only (no DGPS available).
NASA801 (B200)	Garmin GTX-330ES ADS-B/Mode S Skywatch TCAS I Garmin GNS-430W GPS Novatel ProPak6 DGPS	N/A	Out (1090 MHz)	NACp - x NIC - x NACv - x SIL - x SDA - x	100 ft	140, 150, 160, 180, 210, 250	1,000 ft AGL to 18,000 ft MSL	140-250	+1,500 -3,000	Medium Speed Large RCS	GPS L1/L2; NASA801 is a public use registerd aircraft. Airspeed window at 15'K MSL is 140-250 KIAS.
NASA856 (TG-14)	L3 LYNX NGT-9000 ADS-B/Mode S Apollo SL70 Mode C Ashtech Z Extreme DGPS	N/A	In (978/1090 MHz) / Out (1090 MHz)	NACp - x NIC - x NACv - x SIL - x SDA - x	25 ft 100 ft	65, 100	1,000 ft AGL to 10,000 ft MSL	65-100	+450 -2,000	Low Speed Small RCS	GPS L1/L2 diversity antenna; Skywatch capable; LYNX Wi-Fi capable; Aircraft performance data at 9,000 ft MSL. Capable of maintaining a 3200' turn radius for 2 minutes using 11° bank angle at 70 kt.
NASA808 (G-III)	Universal UNS-1Ew FMS/GPS BendixKing TPU-67A TCAS II Rockwell Collins TRD-94D ADS-B/Mode S Novatel ProPak6 DGPS	N/A	Out (1090 MHz)	NACp - x NIC - x NACv - x SIL - x SDA - x	25 ft	300, 400, 425	9,500 - 18,000 ft MSL	125-340	+3,000 -6,000	High Speed Large RCS	GPS L1/L2; TCAS II ver 7.0 (upgrade to 7.1 pending); V_{MO} is 340 KCAS (below 28K ft MSL); NASA808 is an FAA registered aircraft, therefore, modifications require a FAA inspection and approval; Airspeed window at 15'K MSL is 125-340 KIAS.

***ADS-B Out Ground Test Predicted Performance Requirements (14 CFR 91.227 & AC 20-165A)**

• NACp ≥ 8	EPU <0.05 nm
• NIC ≥ 7	R_C < 0.2 nm
• NACv ≥ 1	<10 m/s
• SIL ≥ 3	≤$1x10^{-7}$ per hr
• SDA ≥ 2	≤$1x10^{-5}$ per hr

¨All aircraft performance figures are based on clean, level flight, mid-weight, standard day conditions at 15,000 ft MSL (except TG-14 which are at 9,000 MSL).

Note: Data marked in red represents notional, planned or missing.

Appendix H FT4 Flight Test Matrix

FLIGHT TEST 4 SCRIPTED ENCOUNTERS COMBINED MATRIX

Intruder	Type
High Speed	Multiship
Medium Speed	
Low Speed	

Manual Change

Leg Time 3.0

Lateral Sep 0.4 NM
2430 ft

Low speed 3 deg/s standard ROT
High Speed 1.5 deg/s half standard ROT

Kludges:
*For 90 angle into, use CPA to IP TC (180 degrees)

General Scenario Setup

Stakeholder	Scenario Number	PE Name/Type	Priority (1-high, 2-medium, 3-	Name	Ownship TC (IP to CPA)	Leg Time (minutes)	Total Encounter Length	Ownship Angle	Angle Into Int 1	Angle Into Int 2	Vertical Offset Int 1 (ft)	Vertical Offset Int 2 (ft)	Lateral Offset INT1 (ft)	Lateral Offset INT2 (ft)	GS OWN	GS INT1	GS INT2	GS INT3	GS INT4	O/S Above	Altitude Regime	Ownship Initial Altitude	Ownship Vertical Velocity	Ownship Final Altitude
SSI WEST JADEM	001	SSIWest.1.a	1	001-Am-S5H	270	2.0	2.0		0		500		0		200	420				1	>10K MSL	15500	0	15500
	002		1	002-Am-S5H	270	2.0	2.0		45		500		0		200	420				1	>10K MSL	15500	0	15500
	003		1	003-Am-S5H	180	2.0	2.0		90		500		0		200	420				1	>10K MSL	15500	0	15500
	004	SSIWest.1.b	2	004-Am-S5H	270	2.0	2.0		0		500		0		200	420				1	>10K MSL	16000	0	16000
	005		2	005-Am-S5H	270	2.0	2.0		45		500		0		200	420				1	>10K MSL	16000	0	16000
	006		2	006-Am-S5H	180	2.0	2.0		90		500		0		200	420				1	>10K MSL	16000	0	16000
	007	SSIWest.1.c	1	007-Am-S5H	270	2.0	2.0		0		500		0		180	300				1	<10K MSL	9000	0	9000
	008		1	008-Am-S5H	270	2.0	2.0		45		500		0		180	300				1	<10K MSL	9000	0	9000
	009		1	009-Am-S5H	180	2.0	2.0		90		500		0		180	300				1	<10K MSL	9000	0	9000
	010	SSIWest.1.d	2	010-Am-S5H	270	2.0	2.0		0		500		0		180	300				1	<10K MSL	9000	0	9000
	011		2	011-Am-S5H	270	2.0	2.0		45		500		0		180	300				1	<10K MSL	9000	0	9000
	012		2	012-Am-S5H	180	2.0	2.0		90		500		0		180	300				1	<10K MSL	9000	0	9000
	013	SSIWest.1.e	1	013-Am-S5L	90	2.0	2.0		0		500		0		120	100				1	<10k MSL	9000	0	9000
	014		1	014-Am-S5L	90	2.0	2.0		45		500		0		120	100				1	<10k MSL	9000	0	9000
	015		1	015-Am-S5L	90	2.0	2.0		90		500		0		120	100				1	<10k MSL	9000	0	9000
	016	SSIWest.1.f	2	016-Am-S5L	90	2.0	2.0		0		500		0		120	100				1	<10k MSL	9000	0	9000
	017		2	017-Am-S5L	90	2.0	2.0		45		500		0		120	100				1	<10k MSL	9000	0	9000
	018		2	018-Am-S5L	90	2.0	2.0		90		500		0		120	100				1	<10k MSL	9000	0	9000
	019	SSIWest.2.a	1	019-Am-S4M	90	1.0	1.0		0		400		2430		150	180				0	>10k MSL	11000	0	11000
	020	SSIWest.2.b	1	020-Am-S4M	90	1.0	1.0		0		400		2430		150	180				0	>10k MSL	11000	0	11000
	021	SSIWest.2.c	1	021-Am-S4M	90	1.0	1.0		0		400		2430		150	180				0	<10k MSL	9000	0	9000
	022	SSIWest.2.d	1	022-Am-S4M	90	1.0	1.0		0		400		2430		150	180				0	<10k MSL	9000	0	9000
	023	SSIWest.2.e	2	023-Am-S3M	270	1.0	1.0		0		300		2430		150	150				1	>10K MSL	12000	0	12000
	024		2	024-Am-S3M	270	1.0	1.0		45		300		2430		150	150				1	>10K MSL	12000	0	12000
	025		2	025-Am-S3M	180	1.0	1.0		90		300		2430		150	150				1	>10K MSL	12000	0	12000
	026		2	026-Am-S3M	270	1.0	1.0		0		300		2430		150	180				1	>10K MSL	12000	0	12000
	027		2	027-Am-S3M	270	1.0	1.0		45		300		2430		150	180				1	>10K MSL	12000	0	12000
	028		2	028-Am-S3M	180	1.0	1.0		90		300		2430		150	180				1	>10K MSL	12000	0	12000
	029		2	029-Am-S3M	270	1.0	1.0		0		300		2430		150	210				1	>10K MSL	12000	0	12000