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COVER SHEET
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Abstract:
Provides preliminary findings of the initial series (normal operations and contingency management) of airspace operations simulations. The key elements of this report discuss feedback from controller subjects for UAS flight above FL430. Findings provide initial evaluation of routine UAS operations above dense ARTCC airspace (ZOB), and identify areas of further research, policy direction and procedural development. This document further serves as an addendum to the detailed AOS simulation plan (Deliverable SIM001), incorporating feedback from FAA air traffic personnel and Access 5 IPTs.

Status:

SEIT-Approved

Limitations on use:
This document is based on findings from simulations involving non-NATCA controller subjects. Access 5 was unable to arrange for NATCA participation during ongoing FAA-NATCA contract negotiations.All UAS missions utilized in these simulations were designed for operations above FL430, specifically to avoid questions regarding RVSM compatibility. While recorded ZOB traffic samples were adjusted to bias the flow to higher altitudes, traffic above FL430 remained sparse; further simulations are necessary to evaluate operations at densely populated altitudes (some contingency operations were evaluated for penetration below FL430, however... e.g. engine out).

Preliminary Airspace Operations Simulations Findings Report

Access 5 Simulation IPT
October 31, 2005

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

1.0 Executive Summary

This report presents the preliminary findings resulting from simulations conducted for Access 5 by the Simulation IPT at NASA Ames Research Center during July and September of 2005. The first series of simulations were conducted to evaluate normal (non-contingency) UAS operations above FL430 within the NAS. The second series of simulations focused on contingency management procedures (also above FL430). Both series of simulations were conducted in Cleveland Center (ZOB ARTCC) airspace within Super High Sectors 26 (Lake), 29 (Wayne) and Ultra High Sector 45 (Geauga). For reasons beyond control of the Access 5 community, NATCA involvement in the simulations was not available; ZOB area supervisors provided radar separation services. While certified to provide radar separation services for the simulated airspace, supervisors' daily duties do not include separation service. For this reason, the findings in this report should be considered preliminary until they can be confirmed through simulations involving NATCA controllers that work traffic on a daily basis.

No significant obstacles to routine UAS operations above FL430 were identified in either series of simulations. The table below summarizes the key findings from the simulations. The severity indicates the level of impact the finding would have on enabling routine UAS operations above FL430, while the confidence provides the Simulation IPT's confidence that the finding is genuine (rather than a result of lack of fidelity, modeling, or controller/pilot performance and qualifications). A discussion of each finding follows in the body of the report.

Table 1. Preliminary AOS Findings

Finding #	Description	Severity	Confidence
1.1	Increased data block clutter due to low UAS speeds	Medium	Low
1.2	Increased sector coordination for complex missions	Low	High
1.3	Separation techniques easily adapted to UASs	Low	Medium
1.4	Methods for communication of UAS mission prioritization need to be defined	Low	High
1.5	Means and breadth of distribution of UAS mission profile information need to be defined	Low	High

1.6	UAS operations did not impact operational safety	Low	Low
2.1	UAS intent information vital to effective management of contingencies	Medium	High
2.2	Contingency procedure timing requires reference for controller to be effective	Low	High
2.3	Reversing course and holding as a contingency procedure was found objectionable in busy airspace	Low	High
2.4	Emergency descent through dense airspace was easier than anticipated due to slow descent of UAS vehicle	Low	Medium
2.5	Holding to reacquire C2 link estimated to be more difficult for higher performance UAS vehicles due to increased turning radius	Low	High
2.6	Continue on route preferred over holding for reacquiring C2	Low	Medium
2.7	Delay-to-initiation of contingency procedures could surprise controller.	Medium	Medium
2.8	Indication of loss link (squawk) needed whenever vehicle is non-responsive to controller commands (even for a brief period)	Medium	High
2.9	Crossing grid-based mission routing create additional workload for controller	Low	High
2.10	“Cannot comply” response required for non-responsive UAS (with intact voice link)	Low	High
2.11	Review of standard contingency procedures warranted for UAS context and applicability.	Medium	High
2.12	UAS Missions should not continue as normal when C2 is lost (no waiting for reacquire)	Low	Medium
2.13	Increased communication may be possible between UAS pilot and ATC during declared emergency	Low	High

While not indicating any significant obstacles to enabling routine UAS operations at very high altitudes, the simulation IPT is preparing to address the issues highlighted here, and expand the evaluation domain to include lower altitudes and Air Vehicle Control Station functions. As proposed technologies mature, their suitability for and impact on routine operation within the NAS (across the altitude spectra and at varying levels of traffic) will be evaluated.

This report is organized as follows: First, a brief review of the role of the Simulation IPT in support of Access 5 objectives is presented for context. Next, a high-level overview of the progression of simulation activities through the course of the Access 5 program is given. A discussion of each of the simulation series is presented with supporting documents referenced in the appendices, along with a detailed discussion of preliminary findings. Lastly, future simulation activities are outlined to address remaining questions and unresolved issues.

2.0 Background

The Simulation IPT charter reads as follows:

> Through comprehensive simulation, compliment a Flight Demonstration program in the evaluation of technologies, policies and procedures needed to achieve the Access 5 goals of safe, efficient and routine operation of HALE UASs in the NAS.

The role of simulation within the project is to provide the proof required to convince NAS stakeholders that the recommendations resulting from Access 5 activities would achieve the project vision if implemented. To fill this role, a few key relationships have developed that will assist the simulation IPT in presenting a more appealing body of evidence to support the Access 5 recommendations.

The Policy IPT is utilized as a conduit of communication and cooperation with key personnel within the Federal Aviation Administration (FAA), namely individuals within the FAA's Air Traffic, Flight Standards and Certification organizations. Open communication is key to receive guidance and feedback on simulation activities toward meeting the specific needs of these groups. The Policy IPT is also tasked with coordinating the routine communication between domain experts within the FAA and the simulation principal investigators required to achieve the highest practical level of simulation realism and value. Communicating Access 5 activities (including simulation) to other NAS stakeholders (commercial operators, private pilots, community groups, etc.) is managed by the Strategic Communication group.

Furthermore, Human Systems Interface (HSI) activities within the Technology IPT and simulation development and analysis require similar inputs for evaluation (e.g. mission decomposition, task analysis). Tight integration with the HSI work package participants in the form of teleconference participation and coordination of common tasks eliminates duplication of efforts. Furthermore, by involving HSI participants in the simulation planning process, the risk of needing to repeat studies due to inadequate Human Factors (HF) consideration is greatly reduced.

The role of the simulation IPT in support of both Step 1 functional requirements development and recommendations for experimental certification basis, is (at times) at odds with the most urgent concerns of those tasked with providing air traffic services: the FAA air traffic community. Most pressing in the minds of those tasked with providing services to the UAS operators (and the aviation community in general) are operational issues in dense airspace: specifically, contingency management procedures and operational compatibility with operations within Reduced Vertical Separation Minima (RVSM) airspace and in dense terminal airspace. The incremental approach resulting from the Access 5 detailed planning effort defines Step 1 activities as those occurring above FL400. With the initiation of RVSM activities in January of 2005, the focus of Step 1 simulation activities was shifted even higher (to FL430 and above) to isolate RVSM policy and procedures issues from Step 1 goals (which were intentionally modest, presumably to show early progress and develop a beneficial relationship with other NAS stakeholders). Early feedback obtained from meetings with FAA participants indicated a strong desire to start evaluating UAS operations at lower altitudes in the midst of dense traffic; there was little concern with operations in sparsely populated airspace at and above FL430.

In an effort to simultaneously support the Step 1 Access 5 goals and address the concerns of the FAA, a plan was developed to incrementally lower the simulation airspace domain from FL430 to FL180 (Figure 1). Additionally, simulations devoted solely to the evaluation of normal operations above FL430 were limited to one series (week), advancing to evaluation of contingency management procedures (in addition to normal operations) for the second and subsequent simulation series. Finally, to depict higher traffic density within the domain of Step 1 simulations, recorded traffic samples for the first series of simulations were biased such that traffic levels at higher altitudes were significantly above those normally encountered.

By placing an increased service burden at higher altitudes, issues related to UAS operations in dense airspace could be evaluated above RVSM airspace. However, a limit exists to biasing traffic samples on a number of fronts. First, few aircraft in operation are capable of flying at such high altitudes: as the simulation is based on vehicle specific models, their altitudes are limited by performance of the vehicle types recorded. While vehicle types can be modified in simulation to allow higher altitudes, a homogeneous traffic mix is not realistic. Furthermore, as recorded traffic samples are based on real-world constraints (such as top of descent locations and adherence to inter-facility letters of agreement) realism is guaranteed; as a sample is modified, extreme care must be exercised to maintain realism that is not evident to the casual observer. This tradeoff of goals and realism was managed by developing the simulation scenarios in cooperation with Subject Matter Experts (SMEs) intimately familiar with the simulated airspace. How well this process worked for each series of simulations, and what lessons were learned will be discussed in a later section.

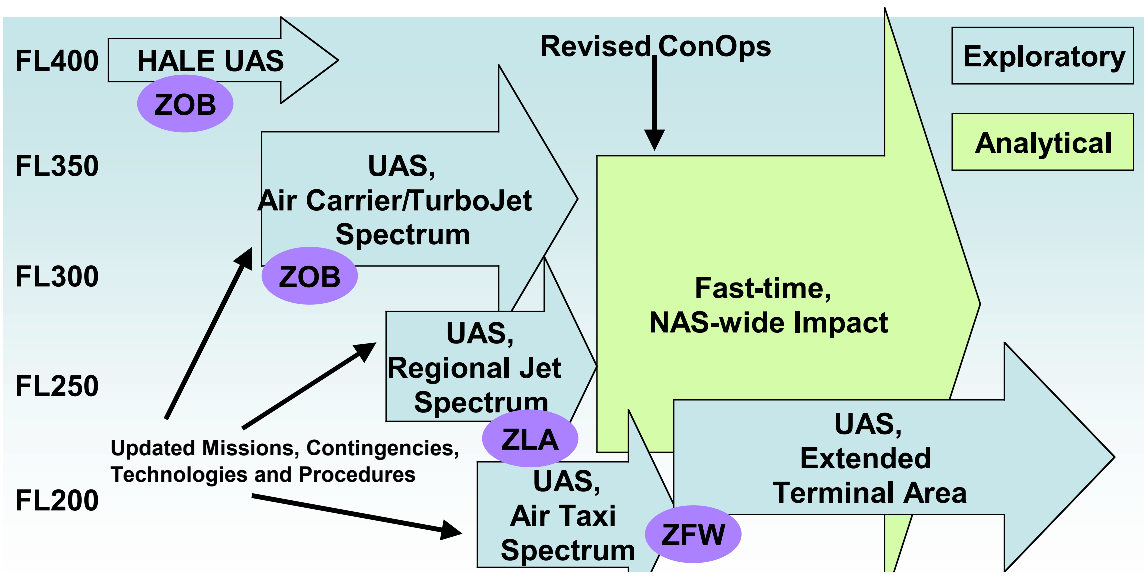


Figure 1: Incremental Approach to Simulation of UAS operations in the NAS

Airspace operations simulations are a single component of the Simulation IPT approach; with AVCS simulation, integrated AO/AVCS simulation and fast time, NAS-wide simulation serving complimentary roles. While this document does not detail the plans for these simulations, the next steps will be outlined later in this report.

With the high-level plan in place, a number of UAS missions were developed in coordination with UAS operators. These missions serve as the set of ingredients available for forming scenarios for individual simulation sessions. When combined with one another, and integrated within a recorded (and biased) traffic sample, these missions are the foundation of all Simulation IPT evaluations. While different combinations of missions, modifications in timing and execution of missions, and varying traffic samples can yield substantially different scenarios, this set is relatively limited, and should not be viewed as exhaustive. Future coordination with the RTCA SC-203 effort would benefit the exploratory approach needed to identify potential operational compatibility issues across a broad range of operating conditions (beyond the Step 1 domain). The vehicle missions are described in detail in Appendix A. How these missions were combined with one another and integrated with traffic samples is discussed in the following sections and detailed in Appendices B and C for the individual simulation scenarios.

Building on this effort, the second series of simulations solicited inputs from each work package toward scenario definition. Specifically, the goal of this solicitation was to focus the refinement of the initial set of scenarios (and the development of new scenarios) on those contingency management issues deemed most urgent by each work package. A detailed discussion of the process for developing the issues matrix, how the issues matrix was utilized, and what the implications were for the second series of simulation is presented in Appendix H

Finally, scenario narratives were developed that can be utilized to accelerate the scenario modification effort in future simulations by providing a sufficient level of detail to script event-based evaluations in the simulation environment (especially useful in planning for AVCS and integrated AO/AVCS simulations). The mission and scenario narratives developed to date are available in the Simulation IPT ACE archives.

3.0 Normal Operations Simulations

3.1Overview/Objectives:

A series of Normal Airspace Operations Simulations (AOS) were conducted during July of 2005 at NASA Ames Research Center's ATC Laboratory. The ATC Laboratory consists of a number of air traffic control workstations (emulating the DSR functionality employed in ARTCC facilities) supported by a target generation capability via push-to-talk communication with pseudo pilots (for control of manned and unmanned aircraft). In AO simulations, no attempt is made to model or evaluate the AVCS interface. The objectives of this initial series of simulations were threefold: 1) to evaluate nominal UAS operations above FL430, 2) to gain experience with simulation of UAS (for both controllers and experimenters), and 3) to identify additional requirements for future simulation activities. This report details the preliminary interpretation of the first objective, and documents the feedback obtained from controllers on improvements that should be made to the simulation capability for future activities.

3.2 Approach:

3.2.1 Domain:

As discussed in the detailed Step 1 AOS plan, it was desired to perform Step 1 simulations in an airspace that would present both complexity and high traffic load at high altitudes (>FL400). Through discussions with the FAA, and leveraging NASA relationships with Air Traffic facilities, Cleveland Center (ZOB ARTCC, or ZOB) was chosen as an appropriately complex and busy airspace. Teleconferences with ZOB traffic management personnel further narrowed the simulation focus to a specific are within ZOB (High Altitude Areas II and IV). Specifically, discussions indicated that GEAUGA (45) sector and the adjacent LAKE (26) and WAYNE (29) sectors provided a good balance of complexity, traffic load, and suitability for a variety of UAV missions previously developed. ZOB sectors are partitioned both horizontally and vertically: with as many as four vertical layers in the simulated airspace. The simulations discussed in this report focus on the highest altitude sectors within ZOB: Super High (Lake and Wayne) and Ultra High (Geauga). Figures 3 and 4 depict this region of ZOB airspace, and the altitudes controlled by these sectors. This airspace exhibits high-density, east-west traffic patterns (at high altitudes for trans-continental flights), initial descents into terminal areas, and overlays a number of metropolitan areas (e.g. Detroit, Cleveland) as well as the U.S./Canadian border (and Lake Erie). Additionally, at the suggestion of ZOB personnel, including sectors from more than one Area reduces staffing concerns and increases availability of controller subjects for simulation.

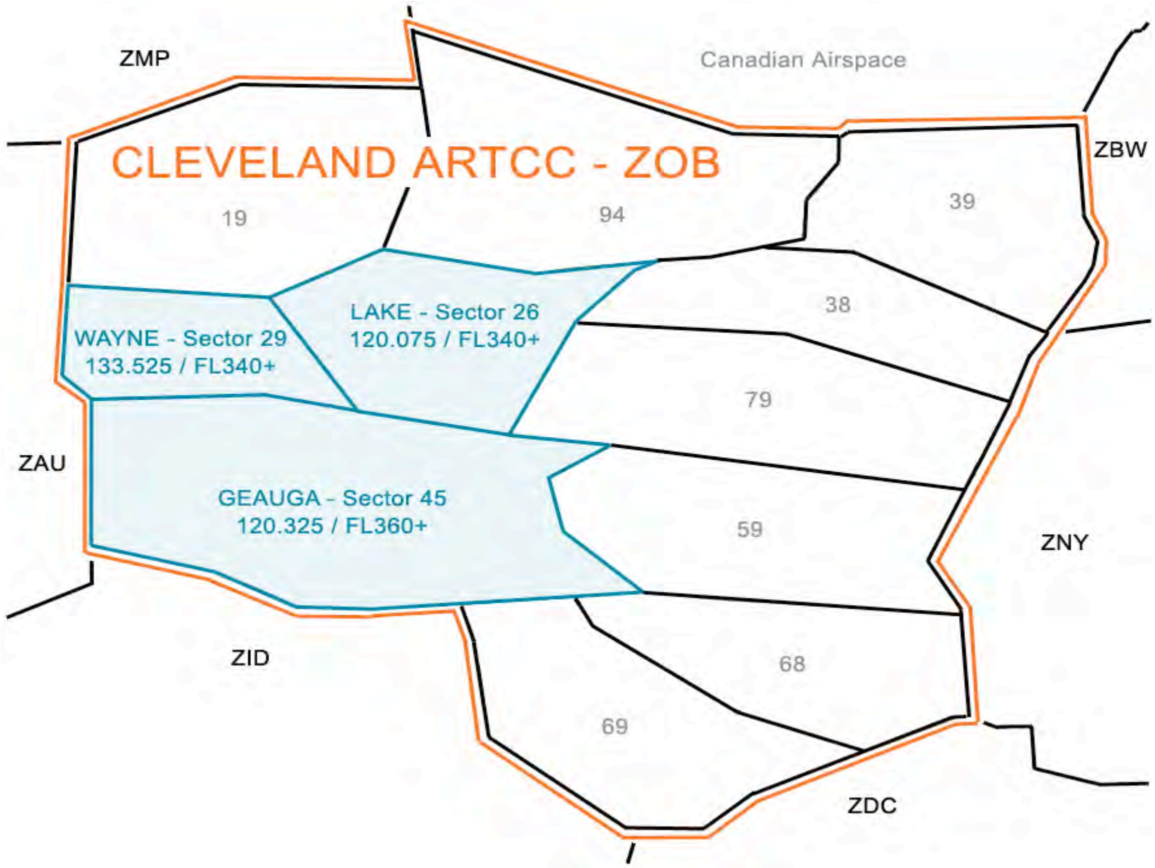


Figure 2: ZOB High Altitude Airspace and Simulation Sectors

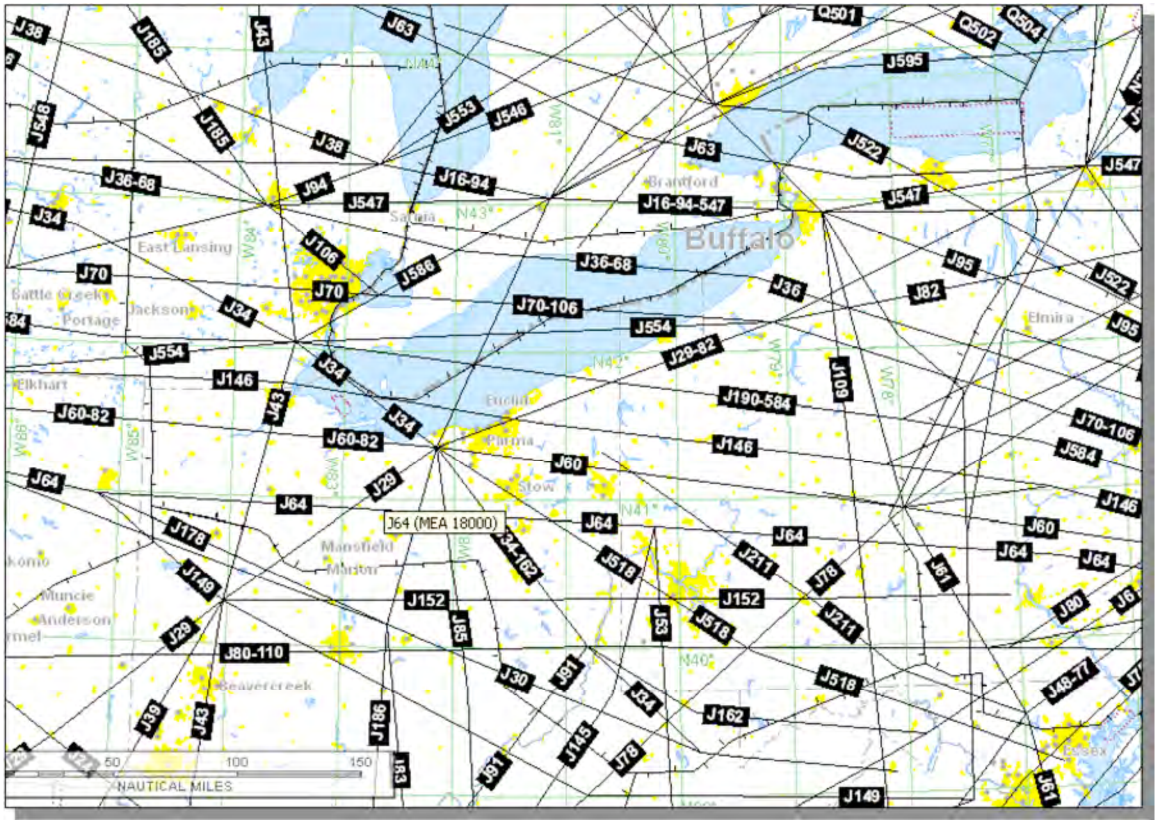


Figure 3: High Altitude Routing Through ZOB Airspace

3.2.2 Missions:

The set of missions developed for the initial series of simulations (normal operations) were developed in cooperation with the Access 5 UAS operators. As previously mentioned, this set should not be considered exhaustive (as it only represents HALE UAS missions, and only those deemed necessary to evaluate Step 1 Access 5 recommendations). Table 1 summarizes the set of 12 missions that were available for development of scenarios for the initial series of simulations. It should be noted, that while missions were developed for a Helios-class vehicle, Perseus B was substituted to perform that mission category due to inadequacies of the Helios performance model in the simulation at the time.

Table 1: Step 1 UAS Mission Set for Simulation

ID	Vehicle(s)	Description
PE-1	Perseus B	Atmospheric ozone sampling mission over northern Ohio urban area
PE-2	Perseus B	Atmospheric ozone sampling mission over northern Ohio urban area; interaction with crossing high-altitude business jet traffic
GH-1	Global Hawk (Solo)	Homeland security radar surveillance of Lake Erie and Moving Target Indication (MTI) track investigation (stand-alone
GH-2	Global Hawk (+ Altair)	Homeland security radar surveillance of Lake Erie and Moving Target Indication (MTI) track investigation (joint with Altair for EO/IR observation)
PE-3	Perseus B (substitute for Helios)	Communications relay over Cleveland Metro area.
PE-4	Perseus B (substitute for Helios)	Communications relay over Cleveland Metro area (second Perseus relieves first at end of time-on-station)
HE-1	Helios	Communications relay over Cleveland Metro area
HE-2	Helios	Communications relay over Cleveland Metro area (change-out of Helios #1 by relief Helios #2).
OF-1	Overflight: Global Hawk + Altair	Overflight with overtaking of slower UAV by faster UAV on same jet route and FL
OF-2	Overflight: JUCAS Formation Change	Two JUCAS UAVs in ZOB airspace closely following; second diverts to different destination than originally filed.
AL-1	Altair (1 air vehicle)	Opportunistic weather cell observation over Northern Ohio
AL-2	Altair (2 air vehicles)	Opportunistic weather cell observation over Northern Ohio (dual cooperating Altairs on station)

3.2.3 Scenarios

A set of eight scenarios and two baseline/practice sessions were developed for the initial series of simulations. These scenarios drew from previously described missions and recordings of live traffic biased to higher altitudes. Figure 4 shows the cyclical nature of air traffic loading within a sample sector. The line labeled “M/A –3” indicates what is considered a current heavy loading within a sector; traffic managers implement strategies to balance workload once sector counts are predicted to breach the M/A (Monitor Alert) – 3 thresholds. The “M/A” labeled line indicates the Monitor Alert threshold that indicates very heavy loading for a sector when more restrictive Traffic Flow Management (TFM) strategies are implemented. These two lines represent an approximation of the loading that was assumed in developing the scenarios for the initial series of AOS. Four scenarios each were developed for heavy loading and very heavy loading. Within these sets, two scenarios included a high level of UAS activity, and two a low level. The scenarios were vetted by demonstrating the scenarios to SMEs from ZOB on a laptop computer and implementing recommended modifications. However, this process was found to be insufficient for the first series of simulations, as will be detailed in the lessons learned section later in this report.

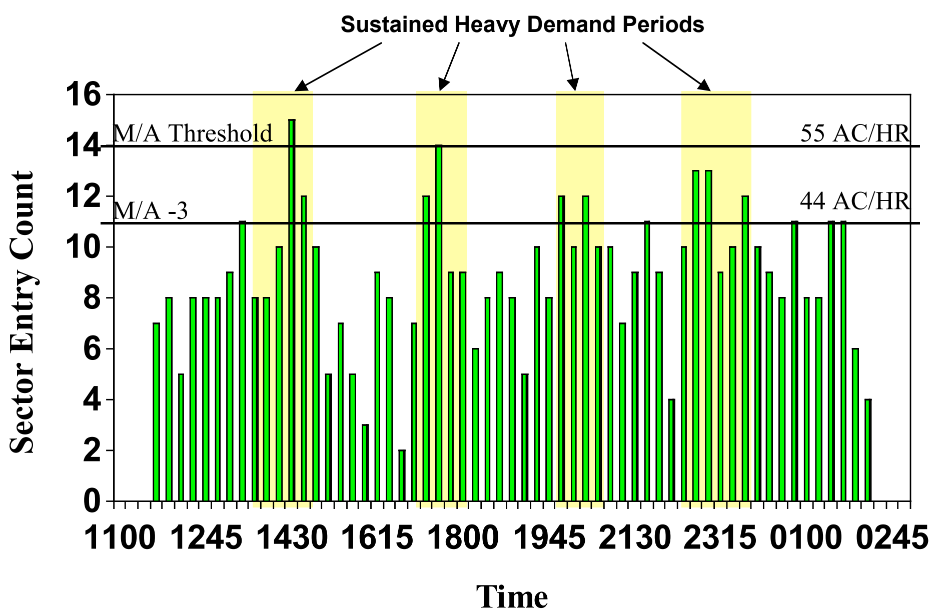


Figure 4: Sample Sector Loading with M/A Thresholds

3.2.4 Conduct:

Prior to the series of simulations, controller subjects (as well as pseudo-pilots) were given a briefing of the goals of the simulations, along with performance characteristics for the UASs involved. Overviews of the individual UAS missions were given in this introductory briefing session. Controllers were next given a hands-on demonstration of the simulation environment, and informed of differences between the simulation environment and the operational environment. Two practice sessions were then conducted to further familiarize controllers with the simulation environment, and to enhance the readiness of the pseudo-pilots for handling the high traffic loads of some of the later scenarios. A short debrief of the days activities concluded the first day of the normal operations simulations series.

The next two days, each of four simulation sessions followed a prescribed pattern of: 1) scenario briefing, 2) simulation conduct, 3) controller questionnaires, and 4) debrief session/discussion. While ‘file-and-fly’ has often been stated as a goal for UAS operations, this is an unrealistic assumption for the missions developed for this simulation. Where missions would require pre-coordination with air traffic facilities (whether manned or unmanned), briefing materials were developed to communicate the mission information to the controller subjects. Appendix D provides the mission briefing materials that were provided to the controller subjects in advance of each simulation session.

Each scenario was conducted according to the prescribed plan of events; controllers simply performed their normal duties (to the extent the simulated environment allowed), and pseudo-pilots followed the stated procedures to carry out each UAS mission while responding to controller directives for all aircraft (manned and unmanned). Two human factors observers were present to collect comments from controllers as the run progressed, and to ask follow-up questions where appropriate.

Following each run, controllers were asked to complete a short questionnaire about the scenario just completed. The questionnaires, and the responses from controllers are included in Appendix F. Once the questionnaires were completed a debrief session allowed other simulation observers to ask questions arising from the session, and allowed controllers to confer with one another on the activities, as well as provide valuable feedback on session realism and environmental deficiencies.

At the conclusion of the simulation activities for the week, a debrief session was conducted to both capture all general comments from the controller subjects, and to come to agreement on what improvements in the simulation environment would be most beneficial to evaluating contingency management procedures in the next simulation series.

3.3 Preliminary Findings:

Briefings and controller questionnaires indicated that there were no significant issues with normal UAS operations above FL430. While controllers indicated some level of increased work was required to monitor UAS operations, they felt this was primarily due to unrealistically high traffic levels for the simulation environment (as will be discussed in the next section). While the simulations indicated no significant incompatibilities with operating UASs in the NAS above FL430, a number of issues and questions were raised:

1) Data block clutter was noted on multiple occasions as increasing workload and complexity for the controller. While much of this was due to the sheer traffic volume encountered in some of the scenarios, it could not be ignored as a potential impact of UAS operations. HALE UAS operations can persist within a small airspace (even within a single sector) for extremely long periods (relative to a routine sector transit operation). This persistence of the target, requires management of data blocks on a continual basis for a single aircraft. This was not indicated as a major concern (there are a number of options to highlight and/or isolate the UAS data block), it could be of concern when there are other aircraft at the same flight level.

2) Coordination between sectors was increased due to the nature of some of the missions. Specifically, the ozone-sampling grid that crossed sector boundaries was noted as requiring coordination and increased attention to ensure any potential conflicts were identified and resolved. While this is not a surprise for the nature of mission (multiple sector boundary crossings), and not unique to the unmanned aspect of UAS operations, it indicates that these types of missions are likely only suitable for very high altitudes or at non-peak hours of operation for the airspace.

3) Vehicle performance was not indicated as impacting complexity or workload. Controllers indicated the very slow moving vehicles required no new techniques for separation. It was indicated that the slow-moving nature of some UAS aircraft would require an adjustment period for controllers to implement effective scan strategies; one more than one occasion, it was noted they kept looking at UAS targets more than they really needed to given the altitude and speed of the vehicle. However, as will be

discussed in the Contingency Management AOS section, controllers rapidly became comfortable with managing UAS operations.

4) Mission prioritization was indicated as useful information when resolving potential conflicts. It is unclear how controllers would receive priority information, or how such priority would be pre-coordinated among UAS operators. Furthermore, it is unclear what priority UAS vehicles performing a mission have compared to manned aircraft transiting the airspace.

5) The controller briefings on UAS missions prior to each session provided sufficient detail to the controllers to manage the UAS operations in their airspace. However, a few questions were raised pertaining to the briefing information. First, it was unclear what the most appropriate means of dissemination of the mission briefings would be. Typically, such missions are coordinated through a facility's "military desk". While this may be the best option in the near term, as the number of UAV operations increase, an alternative may be required if a large number of coordinated missions are commonplace. Furthermore, when such missions exhibit opportunistic elements (e.g Wx observation), the briefing may need to reach a larger controller audience (e.g. adjacent sectors to the planned mission).

6) UAS operations were not indicated as impacting operational safety. All but one response to the question relating to operational safety in the controller questionnaire indicated no impact. Upon follow up, the remaining reply indicated the primary contributor, to what was viewed as a potentially unsafe operational environment, was unrealistically high traffic volume for a single controller (to be discussed in next section).

Overall, the controllers felt there was no significant impact resulting from UAS operations above FL430 in the simulated airspace. Minor modifications to technique might be justified to minimize workload or to enhance situational awareness, and information requirements and distribution need to be determined (briefings and priority). Controller concerns with UAS operations were primarily focused on what would happen if the UAS operations dropped into the dense airspace below. While this is a concern that will be evaluated, these simulations were not an appropriate context for making judgments to that end due to extreme traffic volume.

3.4 Lessons Learned:

Lessons learned from the initial series of simulations identified numerous modifications necessary to enhance future evaluations. Most of the enhancements to the simulation capability were already documented and in development. However, a few notable exceptions are worth mentioning here:

1) The method for vetting scenarios employed in this first series of simulations was insufficient. Traveling to the facility and replaying scenarios on a laptop computer does not provide adequate context for the SME to evaluate the realism of a scenario. The scenarios developed for this series intentionally pushed the traffic volume to very high levels. This was done in an attempt to replicate the stresses of "real world" air traffic control that are not present in a simulated environment. Review of the scenarios at the facility indicated that yes, these were indeed high traffic scenarios, but that they were by no means unrealistic. However, what this review process failed to do, was provide context for the scenario. If the SMEs had been told there would be no radar associate or tracker position for any of the sectors during these sessions, an indication of unrealistic conditions would have likely resulted.
2) Furthermore, the DSR emulation itself did not provide all of the tools necessary to alleviate the increased workload due to lack of associate and tracker assistance. The lack of a DSR keyboard and trackball was noted as the most significant deficiency. Many of the other noted differences were tolerable, and already implemented in the next release of the DSR emulation.
3) Traffic load was unreasonably high for a single radar controller. High traffic load scenarios at lower altitudes (DRVSM) may require a D-Side controller to assist.
4) While the pseudo-pilots did an exceptional job of managing the traffic load, more training to operate an UAS in simulation would have been helpful.. A few pseudo-pilot responses were inappropriate for the capabilities of the vehicle (e.g. visual acknowledgement of traffic, navigational capability, etc.). Specific training to the capabilities of the UASs simulated would eliminate these occurrences.

4.0 Contingency Management Procedures Simulations

4.1 Overview/Objectives

A series of Contingency Management Airspace Operations Simulations (AOS) were conducted during July of 2005 at NASA Ames Research Center's Airspace Operations Laboratory. The AOL facility consists of a number of air traffic control workstations (emulating the DSR functionality employed in ARTCC facilities) supported by a target generation capability via push-to-talk (via VoIP) communication with pseudo pilots (for control of manned and unmanned aircraft). The primary objective of this second series of simulations was to evaluate the proposed procedures for managing the identified set of contingencies for UASs above FL430. This section details the preliminary interpretation of feedback received from controllers through questionnaires and debrief sessions.

4.2 Approach

4.2.1 Domain

The airspace domain remained the same as the first series of simulations, but the facility in which the simulations were conducted was changed. Due to the importance placed on DSR keyboards and trackballs (and a delay in the delivery of DSR equipment to the aforementioned ATC Lab), the AOL facility was used for this series. The AOL facility utilizes DSR keyboards, and a similar (albeit based on Voice over Internet Protocol) voice communications system to the pseudo-pilots. The DSR keyboards were seen as essential to managing the high levels of traffic exhibited by the scenarios of the normal AOS sessions. Lastly, the same ZOB supervisors served as controllers in this series of simulations.

4.2.2 Missions

The core set of missions remained the same for this series (Appendix A).

4.2.3 Scenarios

The scenarios for the CM sessions were based on the scenarios for the normal AOS sessions, but modified to include contingencies during the sessions. The contingencies were defined by the Contingency Management work package, and the procedures were developed in coordination with the CM work package and the Policy IPT, according to the process described in Appendix H (IPT issues matrix). Furthermore, the traffic loading exhibited by the new set of scenarios was reduced to allow for manageability with a single radar controller. The reduced traffic load, along with the use of DSR keyboards alleviated data block clutter and management difficulty. The scenarios and the contingencies placed on the missions within the scenarios are detailed in Appendix C.

4.2.4 Conduct

Sessions were conducted following the same procedure outlined for normal AOS sessions. Of note, the controller briefings for the CM simulations added charts that described all contingency procedures in place for that session. This did not indicate that the controller briefed would encounter a contingency during that session, simply that the procedures outlined would be utilized in the event of a contingency. The controller briefings for the CM sessions are included in Appendix E. The controller questionnaires are consolidated in Appendix G.

4.3 Preliminary Findings

Controller questionnaires and feedback indicated there were no 'show-stoppers' encountered during the contingency management AOS sessions. There were numerous interesting thoughts from controllers that require further analysis and discussion, however:

1) Knowledge of UAS intent is fundamental to effective contingency management within the NAS. When pressed for preference of simulated CM procedures, controller indicated that in general, there was no preference as long as intent was known. Consequently, contingencies in which voice communication was maintained, was of little concern to controllers;

emergencies such as lost power were managed with the same procedures as manned aircraft. Therefore, a reliable method for communicating UAS intent in the event of the broad array of possible contingencies is required. To the extent UASs can be expected to adhere to procedures for manned aircraft, this is preferable, as controllers already know these procedures. Where new procedures must be developed, procedures applicable to all UAS are preferred (as they require no communication to determine intent). Lastly, where mission-specific procedures are required (on-the-fly modification of contingency management procedures), a reliable method of intent communication is essential. During the CM AOS sessions, intent (in the event of lost comm.) was communicated through the area supervisor. While this proved effective in simulation, it is not clear this is sufficient for normal UAS operations (although it may be depending on UAS reliability).

2) Procedure timing requires a reference. Some procedures dictated a delay from onset of contingency to response (e.g. 5 minutes current course, speed, altitude, then return to base). While a controller may be aware of the intent to return to base after 5 minutes, without the knowledge of when the 5 minute clock started, conservative action must be taken by the controller to clear all aircraft in the vicinity if the UAS managing the contingency.
3) While there was little preference given intent, reversing course at altitude caused some concern as a procedure. Within dense airspace, reversing course as the first action to manage a contingency does not play well with standard practice of spacing aircraft in-trail. This procedure was especially objectionable when a hold was called for on the reversed course; it would be unacceptable for an aircraft to reverse course to hold at a busy intersection (especially at lower altitudes).
4) Emergency descent through dense airspace was easier to manage than expected. Controllers indicated the slow speed and descent provided a relatively stationary target to avoid.
5) Controllers indicated holding patterns to reacquire C2 could be more difficult for higher performance UASs (due to larger radius holding pattern), especially

at busy waypoints. A preference for continuing along route was indicated here.

6) Holding to reacquire in general was not well liked. Discussion indicated they felt uneasy about an aircraft holding to reacquire a signal if that failure was the first in a string of failures (which they would have no way of knowing).
7) Delay-based procedures could catch controller by surprise if alternate forms of communication are relied upon (phone call to area supervisor). This would not necessarily be alleviated by a long lead-time… a single leg of the perseus ozone grid took longer than any proposed delay to contingency response.
8) Need to squawk for loss link to indicate non-responsiveness to commands. This requires additional thought for Policy, and ties into reliability. It is clear that a high level of availability is required for see and avoid (and may justify an autonomous see and avoid capability), but this issue is less clear. This indicates that the controller wants to see that a vehicle is loss-link. They indicated that this is "essential". Depending on the definition of "loss-link" to the controller (as opposed to the operator), this could require notification of loss-link to ATC in what today's operators consider a system state (reacquisition). If that is the case, the availability of the link could impact controller workload (even if no contingency management procedure is initiated due to link failure).
9) Missions that traverse the normal flow of traffic within a sector contribute to workload associated with data block management (see normal AOS sims). This could be an issue for operating grid-based missions in dense airspace… could be alleviated by aligning a grid pattern with traffic flow direction.
10) In the event of link interruption (voice comm. ok), if a command cannot be completed immediately, the pilot needs to indicate with a "cannot comply" response to indicate such (waiting for reacquisition not acceptable).
11) Standard procedural timing and order needs to be evaluated in the context of UAS-specific contingencies. For example, it is common practice for pilots to acknowledge a controllers command prior to executing the command (command input). However, if this standard practice is employed just prior to

loss link and comm., the controller will have received verbal confirmation of the last command being received, but the UAS would not be executing that command due to loss-link. Procedures for operation of a UAS AVCS need to be evaluated for these failure modes.

12) Lost comm. viewed controllers as first of a potential string of failures. For this reason, they indicated that mission should not be continued… if the destination is closer than RTB, then fine, but do not continue with such things as sampling grids.

13) Controllers hesitated to ask UAS pilot questions in declared emergency due to the manned circumstance of 'too busy on the flight deck". This is not necessarily the case with UASs, so the controller may be able to maintain more normal communications during a declared emergency.

4.4 Lessons Learned

In part due to the improvements made to the simulation environment since the first series of simulations, and in part due to the improvements made to the scenarios, there are few lessons learned (outside the preliminary findings) for this series of simulations:

1) The addition of the DSR keyboard significantly reduced data block management difficulty. Combined with the reduced traffic volume, data block management was not indicated as a concern for UAS operations in this series of simulations.
2) 'Monitor Alert Threshold –3' sector entry count is a practical limit to the traffic loading for single controller simulation (with DSR keyboard and trackball).
3) Familiarity with UAS operations gained by the three ZOB supervisors during the first series of simulations, combined with this series, led to numerous comments relating to comfort with UAS operations in their airspace. This is significant given the high rate of contingency occurrence during this series; it indicates exposure is key to acceptance.
4) All involved maintained the belief that the operations encountered in the first two series of simulations would be very difficult to manage in RVSM

airspace during peak periods. While it is premature to conclude the missions developed thus far could not be managed at lower altitudes, it is likely they would require extraordinary effort on the part of the controllers and traffic managers. This is not a surprise, as the types of missions simulated would likely not be allowed in this airspace for manned aircraft as well.

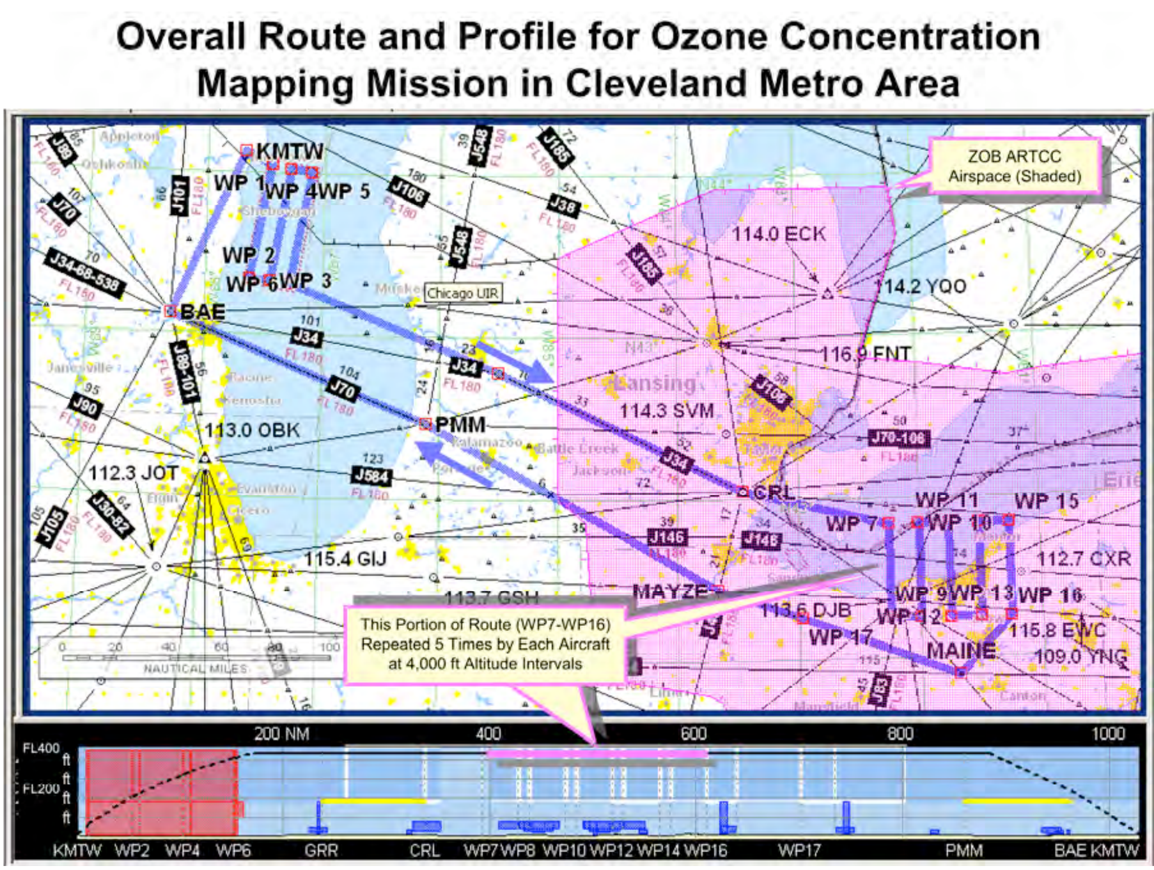
5) Controllers were able to separate the high rate of contingency occurrence from the evaluation of the procedures as atypical of UAS operations; a high level of reliability was assumed in their evaluation.

5.0 Next Steps

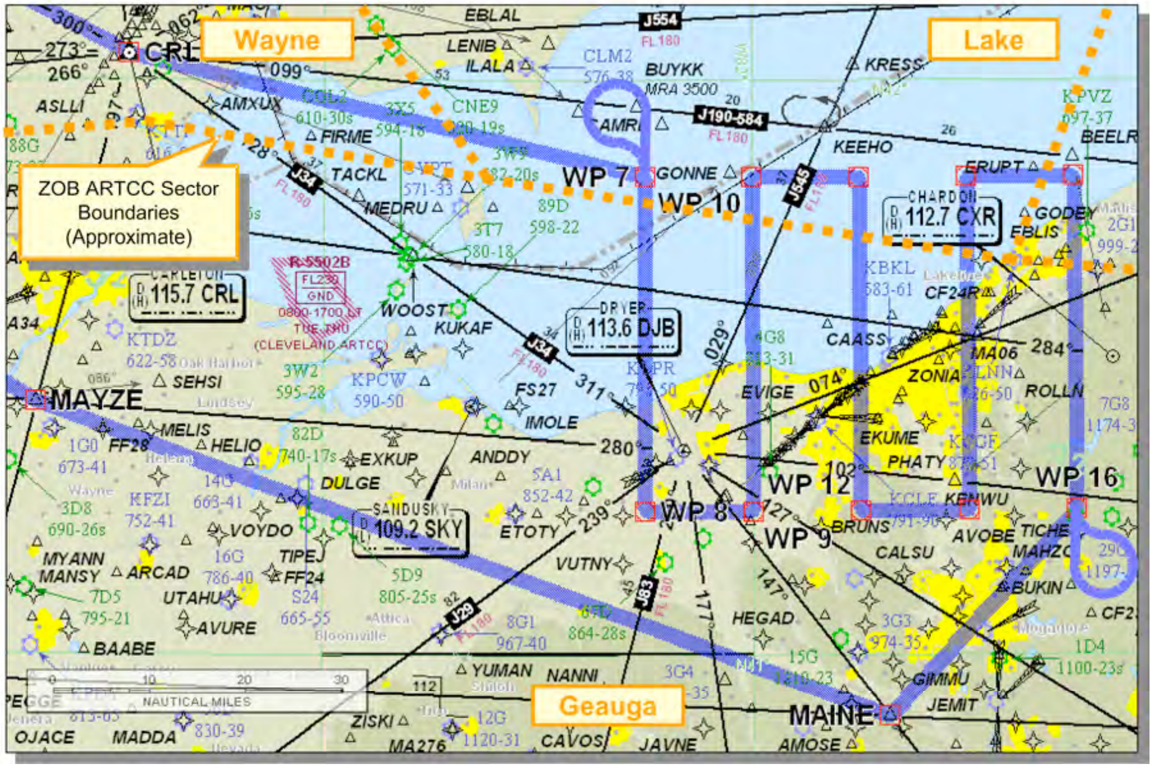
Pending results of the project re-planning effort (FAA sync-up), the Simulation IPT is preparing for a number of simulation efforts in the near future. Part-task AVCS simulations are scheduled for November/December. These simulations will focus on a variety of navigational methods and weather avoidance. Further AOS simulations, as well as integrated AOS/AVCS simulations are scheduled for January/February, and will address remaining contingency management procedures, navigational methods, and will be adjusted to directly address the barriers as defined by the SEIT (including likely reduction in altitude of simulation domain into RVSM airspace).

Appendix A: Step 1 UAS Mission Descriptions

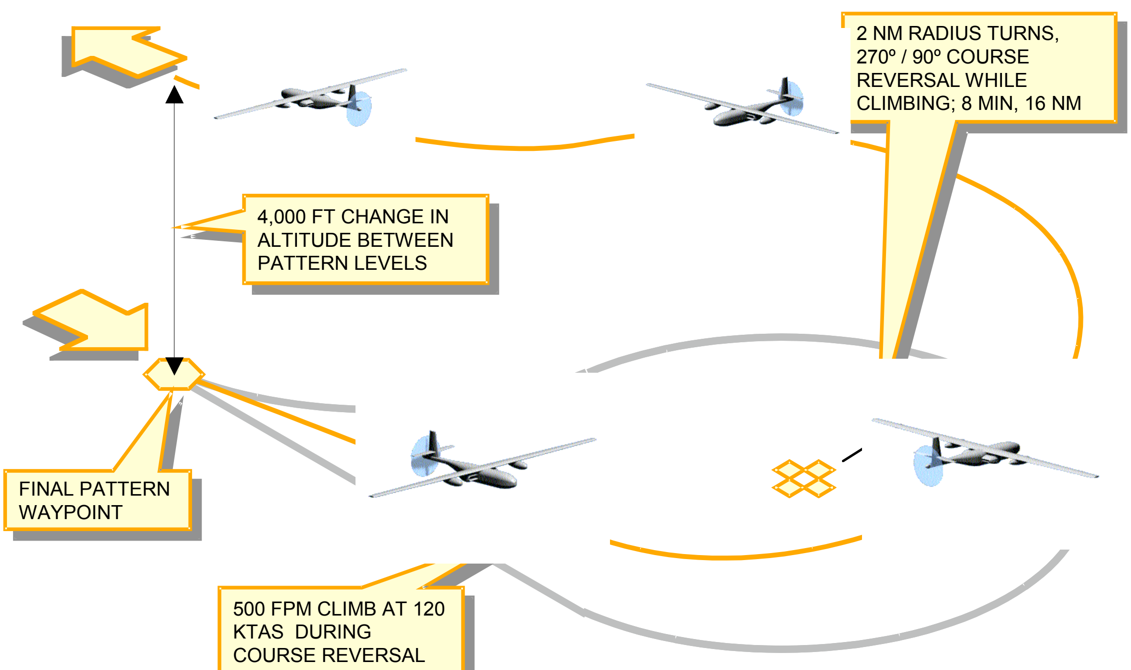
PE-1 and PE-2: Perseus High-Altitude Ozone Concentration Mapping Missions in ZOB Airspace

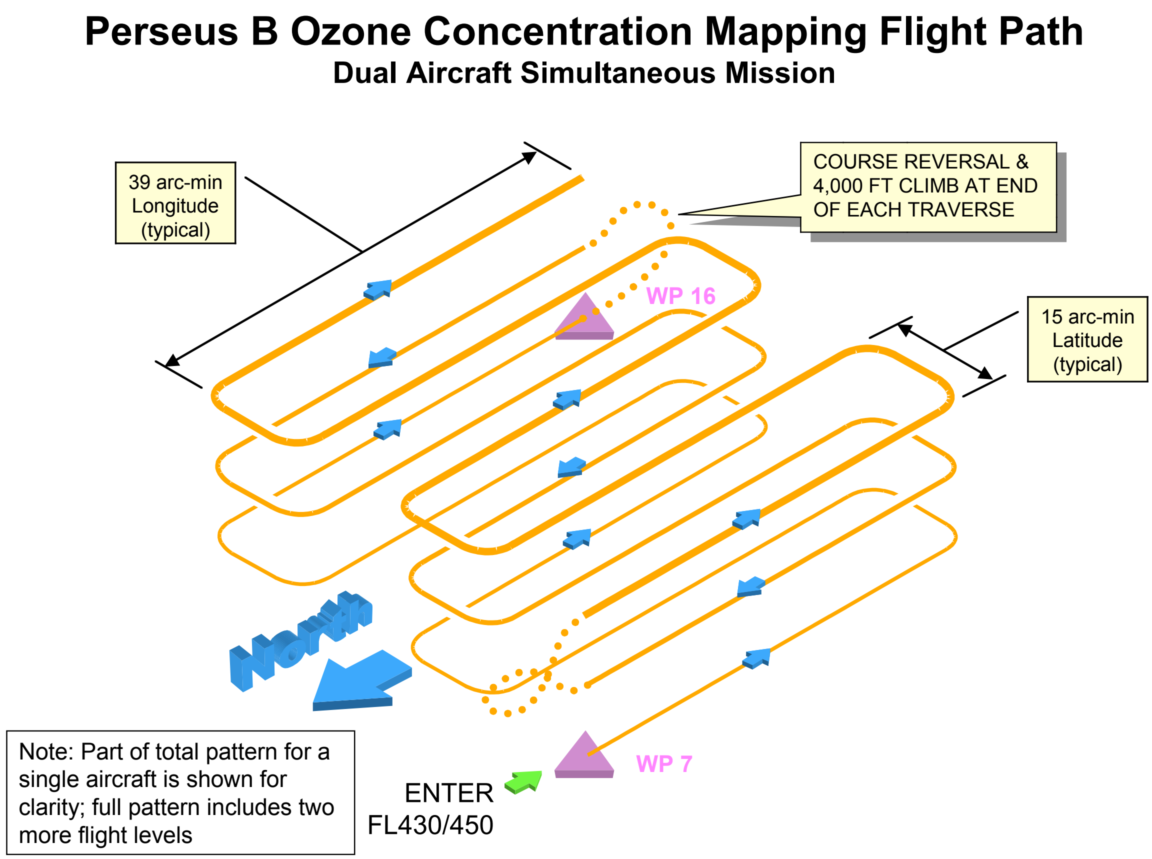


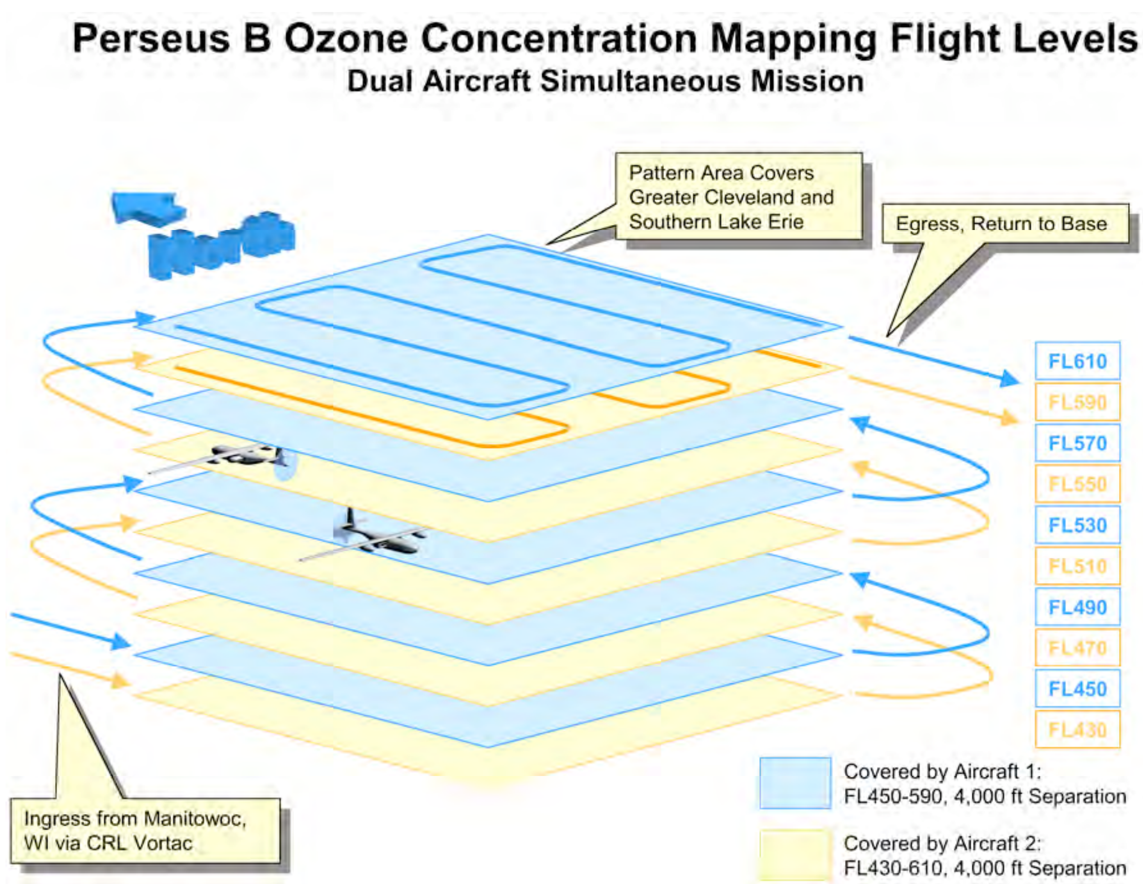
Detail View of Cleveland Metro Ozone Concentration Mapping Route



Course Reversal and Climb to Next Pattern Altitude




Perseus B Ozone Concentration Mapping Flight Path
Dual Aircraft Simultaneous Mission
39 arc-min Longitude (typical)
COURSE REVERSAL & 4,000 FT CLIMB AT END OF EACH TRAVERSE
WP 16
15 arc-min Latitude (typical)
North
Note: Part of total pattern for a single aircraft is shown for clarity; full pattern includes two more flight levels
WP 7
ENTER FL430/450


Perseus B Ozone Concentration Mapping Flight Levels
Dual Aircraft Simultaneous Mission
North
Pattern Area Covers Greater Cleveland and Southern Lake Erie
Egress, Return to Base
FL610
FL590
FL570
FL550
FL530
FL510
FL490
FL470
FL450
FL430
Covered by Aircraft 1: FL450-590, 4,000 ft Separation
Covered by Aircraft 2: FL430-610, 4,000 ft Separation
Ingress from Manitowoc, WI via CRL Vortac

Perseus B Ozone Sampling Route Waypoints

No Wind or Adverse Weather

Location	Mag Crs (deg)	Gnd Spd (kts)	Dist (nm)	ETE (h:m)
Depart Manitowoc Municipal Airport, WI, climb in R6903 to FL430, direct GRR, J34 CRL	E/S	60-120	337	3:18
CLR [Carleton VORTAC]	110	120	55	0:28
WP 7 [N 41° 50', W 82° 15']	188	120	35	0:18
WP 8 [N 41° 15', W 82° 15']	098	120	11	0:06
WP 9 [N 41° 15', W 82° 00']	008	120	35	0:18
WP 10 [N 41° 50', W 82° 00']	098	120	11	0:06
WP 11 [N 41° 50', W 81° 45']	188	120	35	0:18
WP 12 [N 41° 15', W 81° 45']	098	120	11	0:06
WP 13 [N 41° 15', W 81° 30']	008	120	35	0:18
WP 14 [N 41° 50', W 81° 30']	098	120	11	0:06
WP 15 [N 41° 50', W 81° 15']	188	120	35	0:18
WP 16 [N 41° 15', W 81° 15']	188/008	120	16	0:08
Reverse course to WP 16, climb 4,000 ft, repeat pattern in reverse direction (repeat a total of 5 times)	[Egress per route map]			

Total time per pattern:

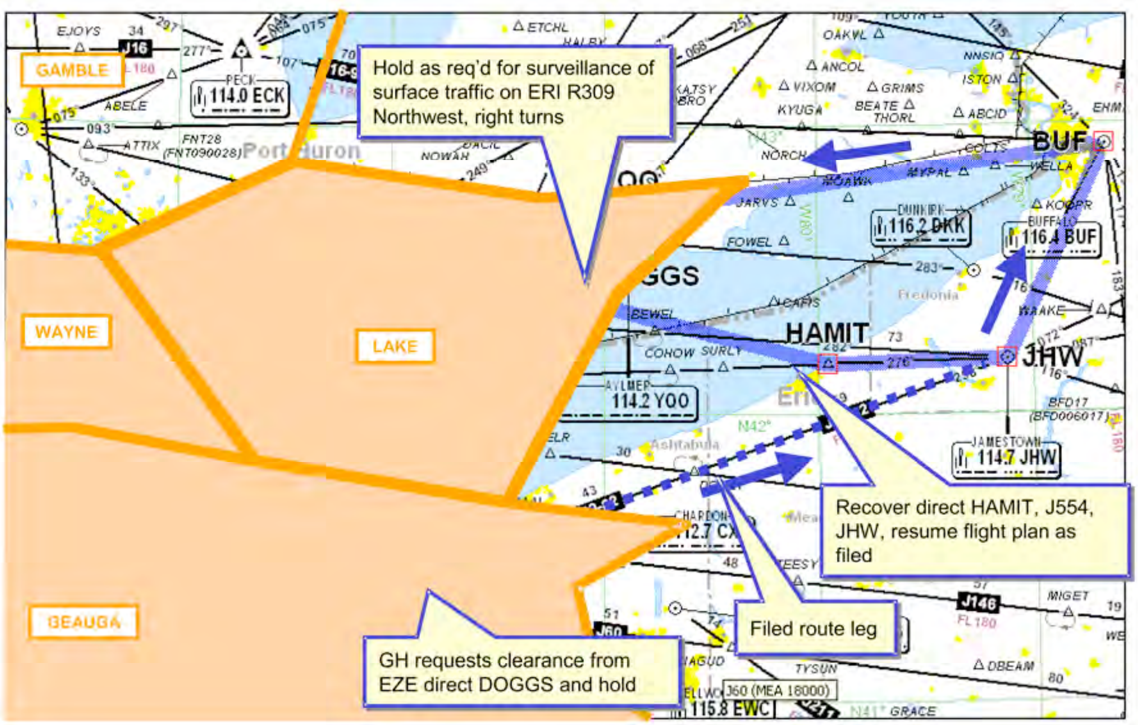
2:02

Five repeats:

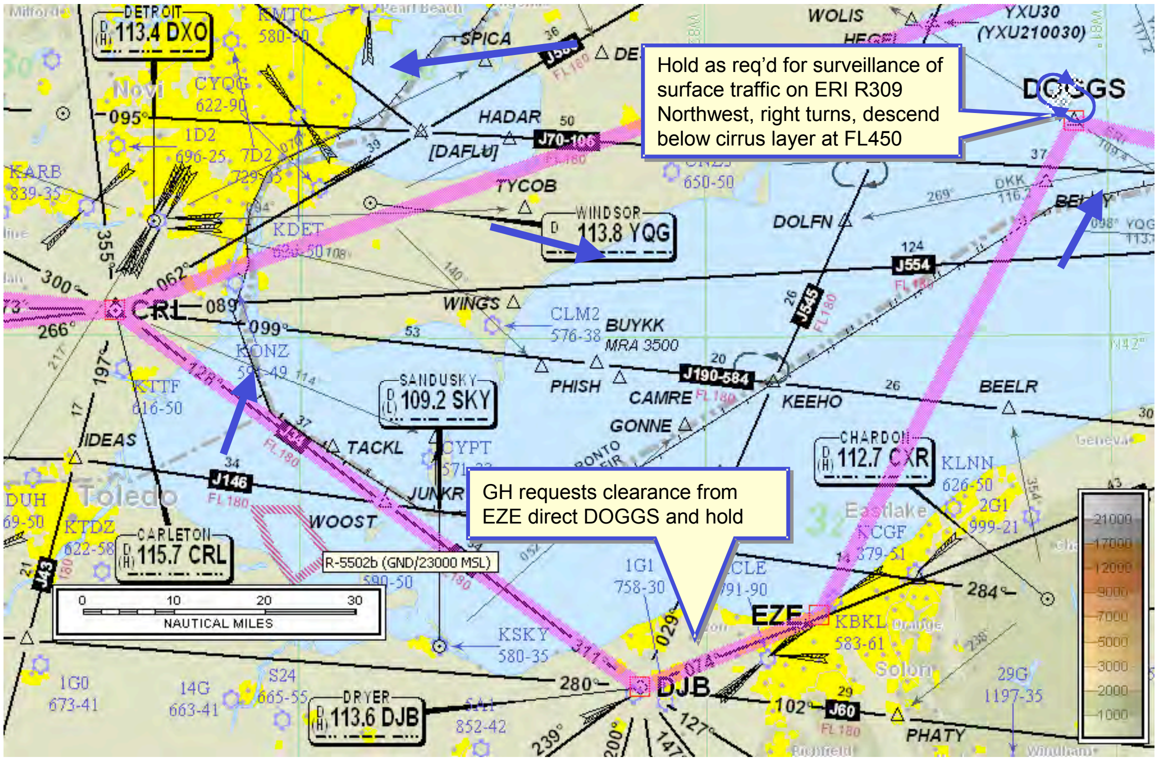
10:10

GH-1: Global Hawk Solo High-Altitude Lake Erie Surveillance Mission in ZOB Airspace

Global Hawk Lake Erie Surveillance Route Showing Deviation



Global Hawk Lake Erie Surveillance Route
Deviation and Hold Detail



Global Hawk Lake Erie Surveillance Route Waypoints

Altitude: FL650, No Wind, 343 KTAS (Design Mission Speed)

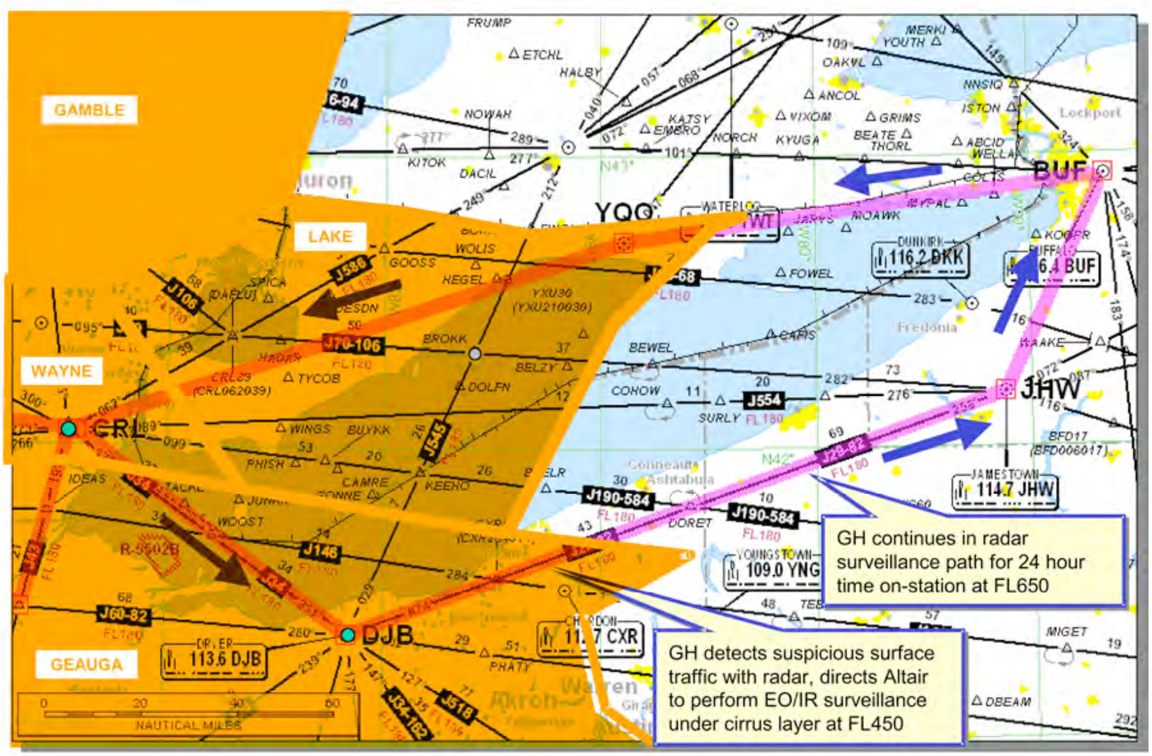
Location	Mag Crs (deg)	Gnd Spd (kts)	Dist (nm)	Time (h:m)
Depart Beale AFB, CA, via great circle route to CRL vortac, climbing to FL650 en route	East NE	N/A	N/A	N/A
CRL Vortac [Carleton]	132	343	265	0:12
DJB Vortac [Dryer]	077	343	71	0:06
EZE Intersection: begin deviation for Lake Erie surface traffic IR/EO detail surveillance	028	343	145	0:09
DOGGS Intersection: enter holding pattern on ERI R309, hold NW, right turns; descend to FL430	309/129	343	As reqd	As reqd
Maintain holding pattern while performing detail surveillance; then depart SE to HAMIT Intersection	114	343	107	0:09
HAMIT Intersection: climb back to FL650	098	343	47	0:09
JHW Vortac [Jamestown]	036	343		0:07
BUF Vortac [Buffalo]	274	343		0:17
YQO Vortac [Aylmer]	261	343		0:21
CRL Vortac: continue circuit for approx 24 hours, then return to Beale AFB via flight plan	Circuit time (without deviation):			1:28

Shaded areas due to detail surveillance route deviation

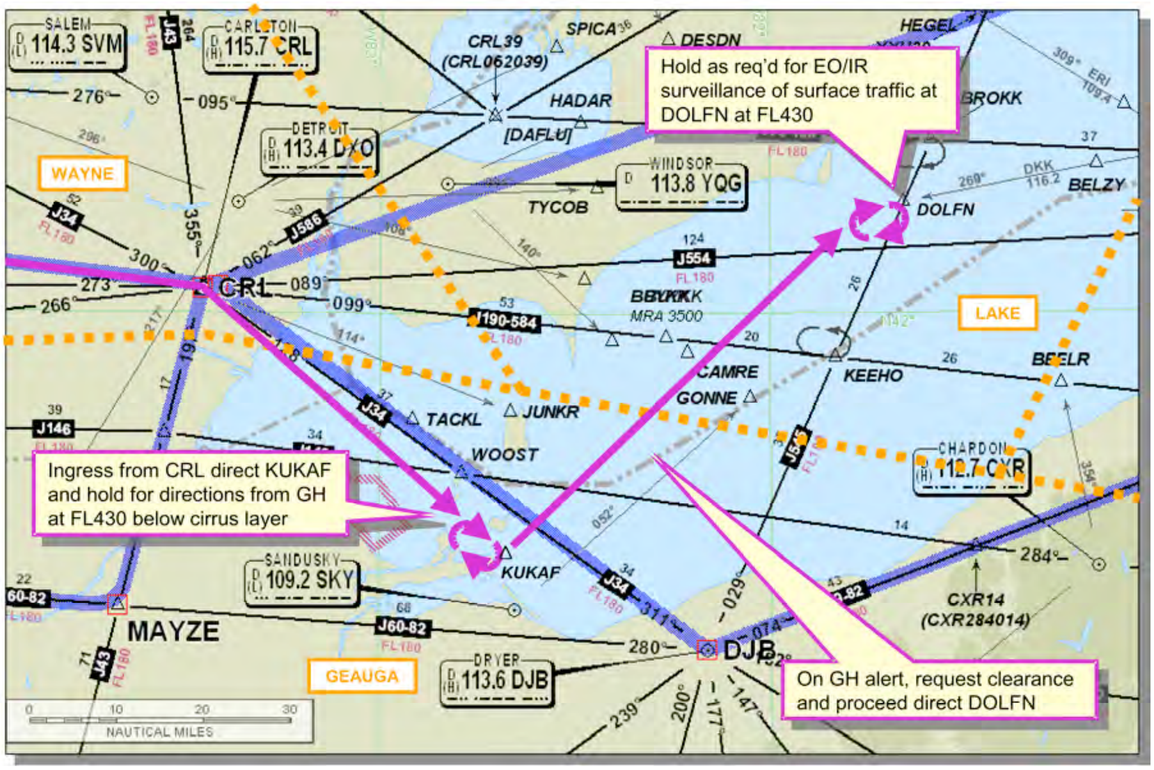
Without deviation, time for DJB-JHW leg = 0:25

GH-2: Global Hawk High-Altitude Lake Erie Homeland Security Mission (Joint with Altair)

Global Hawk Lake Erie Surveillance Route



Altair EO/IR Observation Route



Global Hawk Lake Erie Surveillance Route (Joint Mission with Altair)

Altitude: FL650, No Wind, 343 KTAS

Location	Mag Crs (deg)	Gnd Spd (kts)	Dist (nm)	Time (h:m)
Depart Beale AFB, CA, via great circle route to CRL vortac, climbing to FL650 en route				
	East NE	N/A	N/A	N/A
CRL Vortac [Carleton]				
	133	343	69	0:12
DJB Vortac [Dryer]				
	077	343	145	0:25
JHW Vortac [Jamestown]				
	036	343	47	0:09
BUF Vortac [Buffalo]				
	274	343	100	0:17
YQO Vortac [Aylmer]				
	261	343	120	0:21
CRL Vortac: continue circuit for approx 24 hours, then return to Beale AFB via flight plan			Circuit time	1:24

Altair Lake Erie Surveillance Route Waypoints
(Joint Mission with Global Hawk)

Altitude: FL430, No Wind, 190 KTAS

Location	Mag Crs (deg)	Gnd Spd (kts)	Dist (nm)	Time (h:m)
Depart Manitowoc Municipal Airport, climb to FL430 in R6903, same ingress route as AL-1,	East SE	N/A	N/A	N/A
CRL Vortac [Carleton]	138	190	46	0:15
KUKAF RNAV waypoint: enter holding pattern	138/318	190	19 nm / orbit	6 min / orbit
KUKAF [final crossing]: depart en route DOLFN	055	190	61	0:19
DOLFN intersection: enter holding pattern and hold while performing EO/IR surveillance on surface target	089/269	190	19 nm / orbit	6 min / orbit
DOLFN Vortac [final crossing]: return to alert holding point at KUKAF, repeat per GH alerts	235	190	61	0:19
KUKAF: enter pattern and hold until next GH alert; continue for 24 hours time on-station				

PE-3 and PE-4:

Perseus B High-Altitude Communications Relay Missions Over Cleveland Metro Area

Communications Relay Mission Waypoints

Waypoint/Event	Mag Course (deg)	Altitude: Start/End (ft)	Avg Gnd Speed (kts)	Distance (nm)	ETE (hh:mm)
Depart Erie International Airport (KERI); climb en route to temporary restricted area (Lake Sector)					
WP 1 [N42º 00.0’, W81 º 15.0’] Enter holding pattern within temporary restricted area	**275**	**732 FL200**	**84**	**53**	**00:45**
WP 1 [final crossing] Climb at best rate in holding pattern to FL400	**275/095**	**FL200 FL400**	**95**	**0**	**00:57**
KBKL [Burke Lakefront Airport, Cleveland] Holding fix for initial mission operations; enter operational circular orbit (1 deg/sec turn, 1.2 nm R)	**214**	**FL400 FL440**	**122**	**32**	**00:16**
KBKL [final crossing] Continue climb while performing mission; assume 2 orbits until request to transfer to new fix is necessary	**N/A**	**FL440 FL480**	**140**	**13 nm per orbit = 26**	**6 min per orbit = 00:12**
PARMA Intersection Enter circular orbit over fix for final portion of session; continue climb	**199**	**FL490**	**140**	**4**	**00:02**
PARMA [final crossing] Continue climb while performing relay mission; TBD orbits	**N/A**	**FL490 FL550**	**140**	**13 nm per orbit**	**6 min per orbit**
Return to KERI via approximate reverse of ingress route					

Page 1

HE-1: Helios Communications Relay Mission in ZFW Airspace (Cross-Country Ingress and Egress)

Helios Route of Flight
Ingress to Hold Point

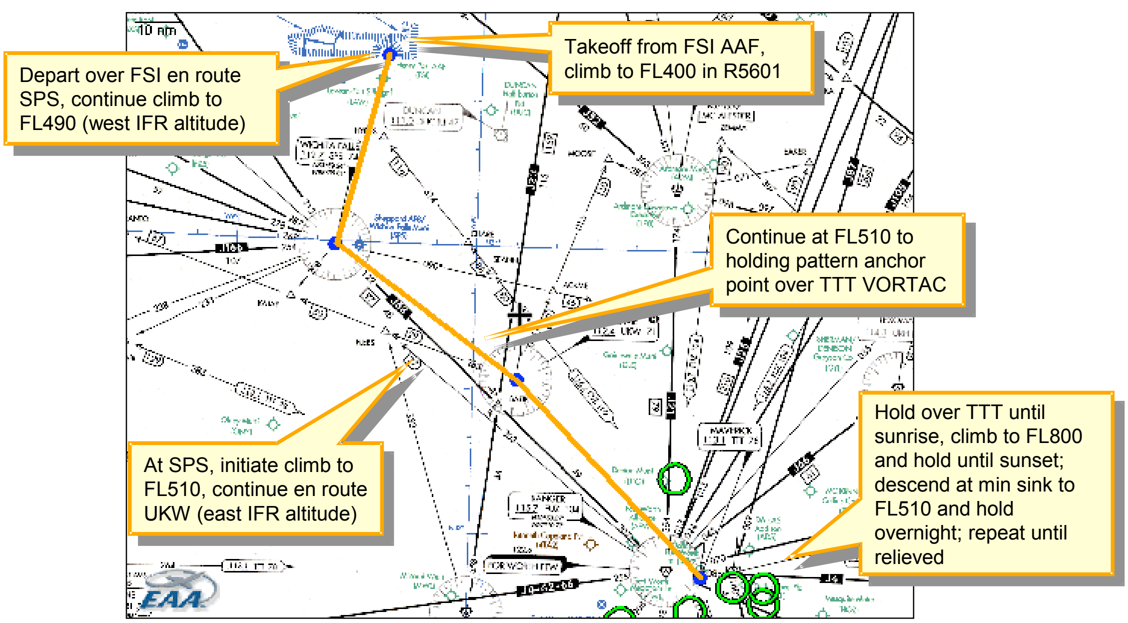
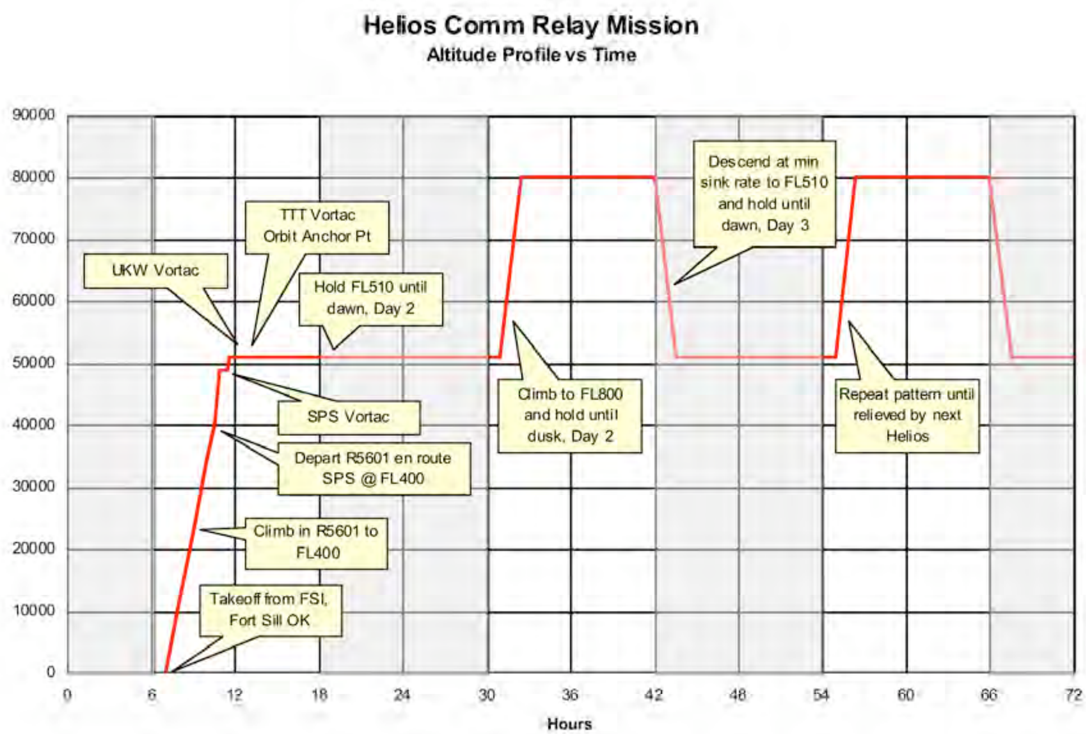


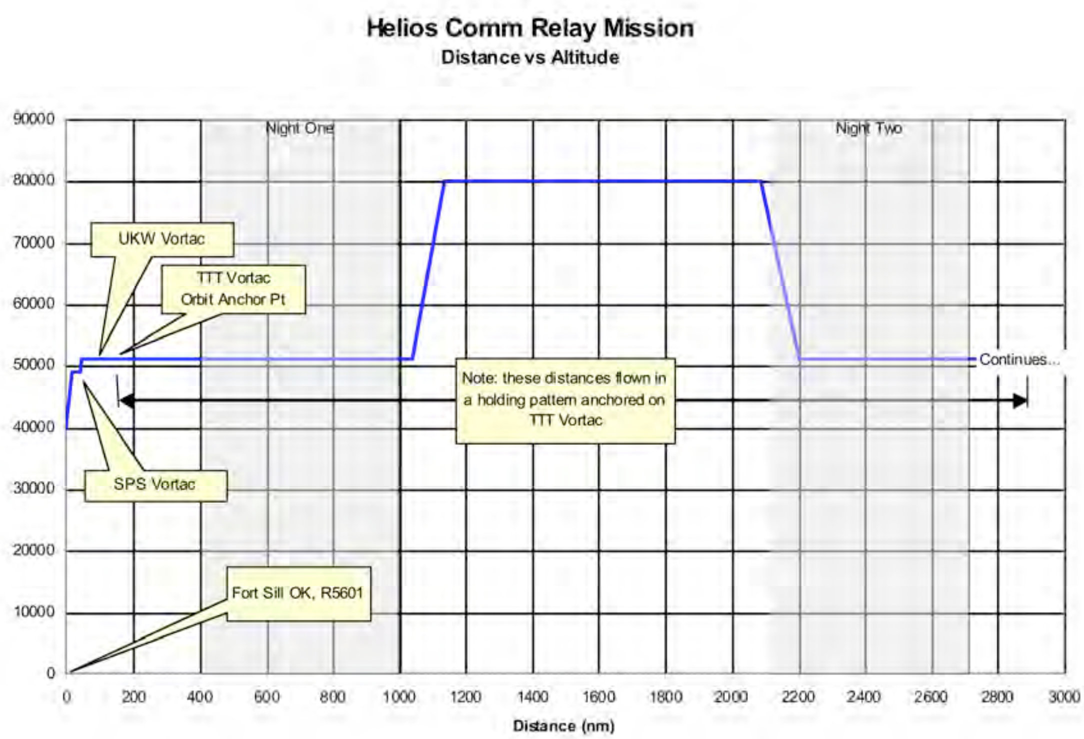
Chart and flight plan courtesy of:
Experimental Aircraft Association
AeroPlanner.com

Typical Helios Altitude versus Time Profile



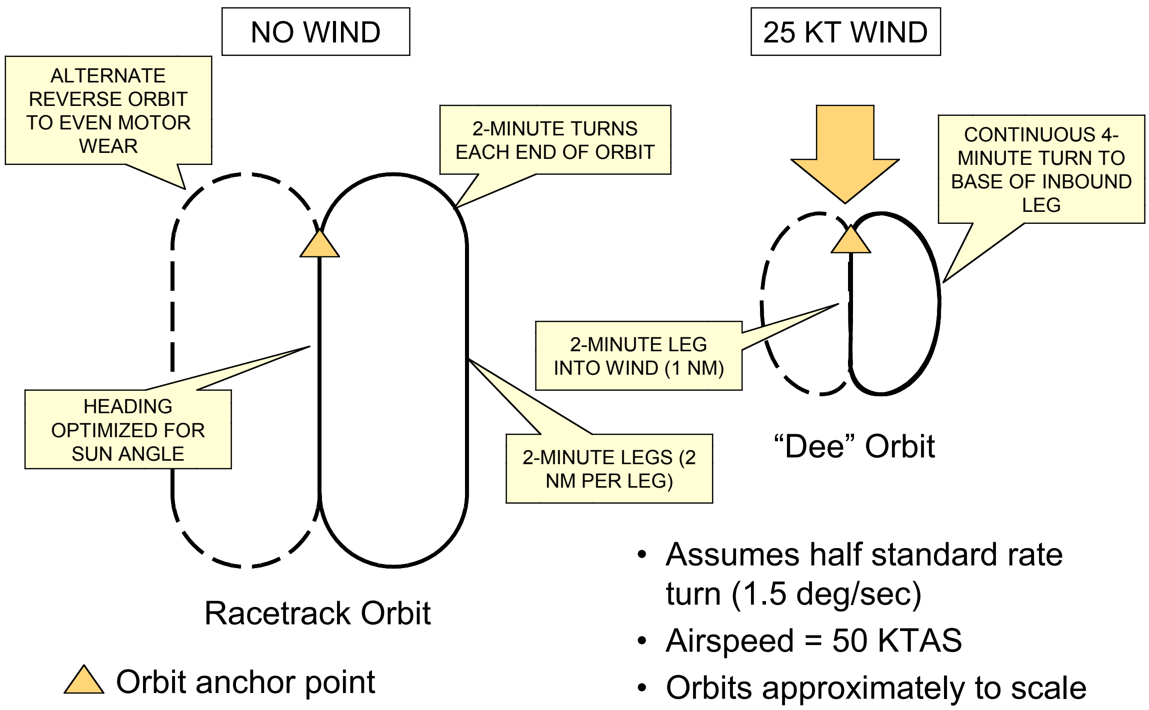
Typical Helios Altitude versus Distance Profile

(Assumes No Wind)



Notional Helios Station Orbits

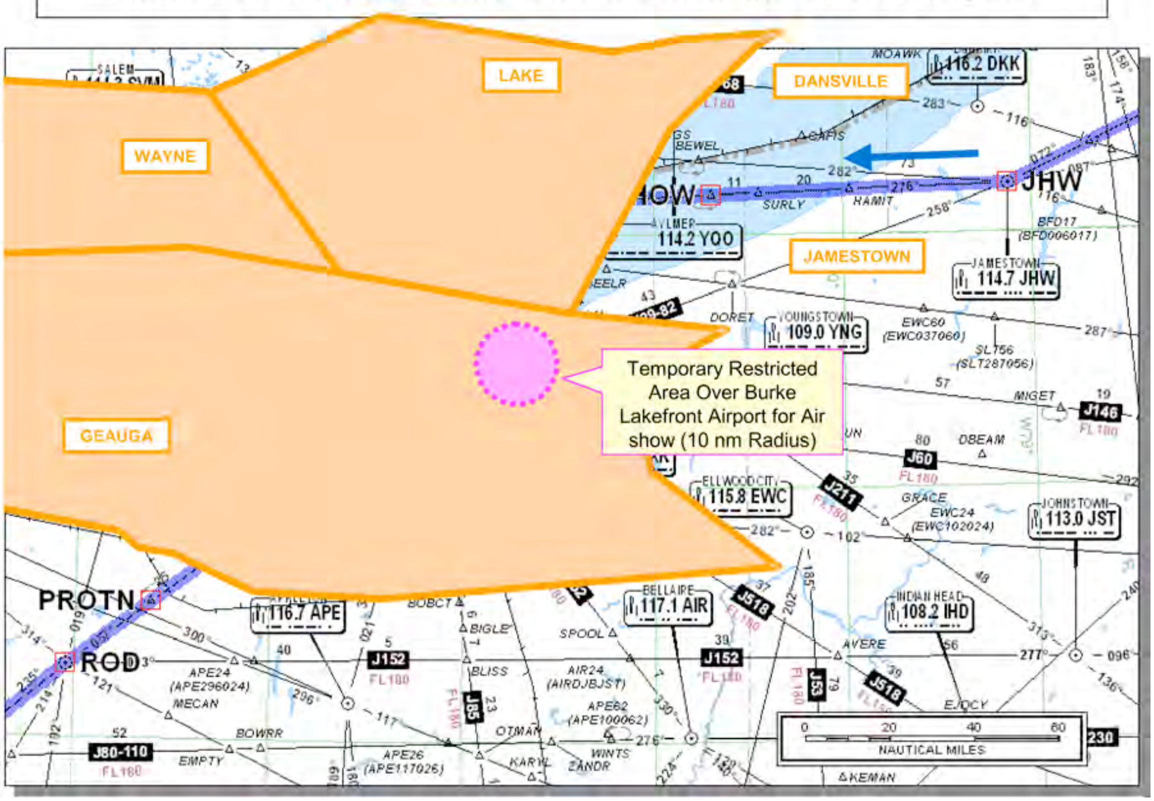
Wind Effects



- Assumes half standard rate turn (1.5 deg/sec)
- Airspeed = 50 KTAS
- Orbits approximately to scale
- Turns use yaw only, no bank

OF-1: Global Hawk / Altair Overflight Overtake in ZOB Airspace

Global Hawk and Altair Route Through ZOB Airspace

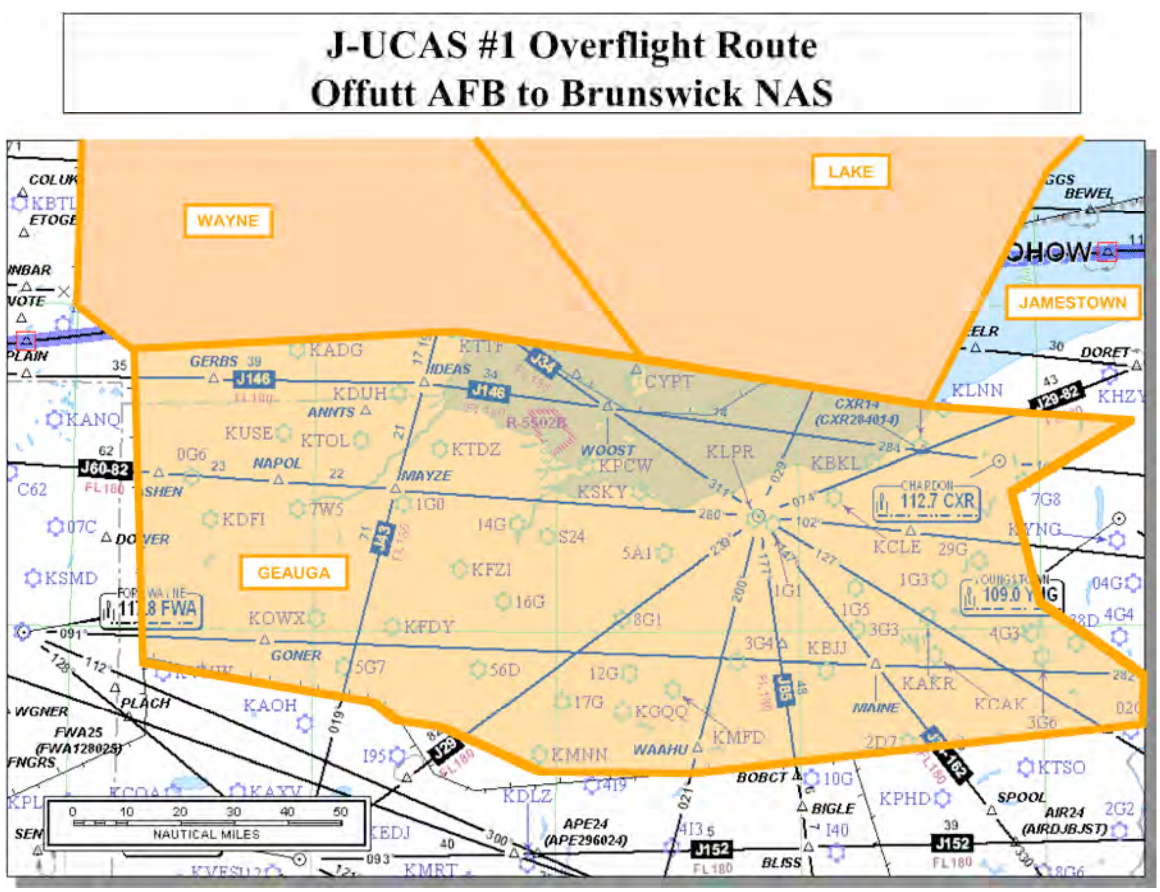


Global Hawk/Altair Overtake Distance and Timing

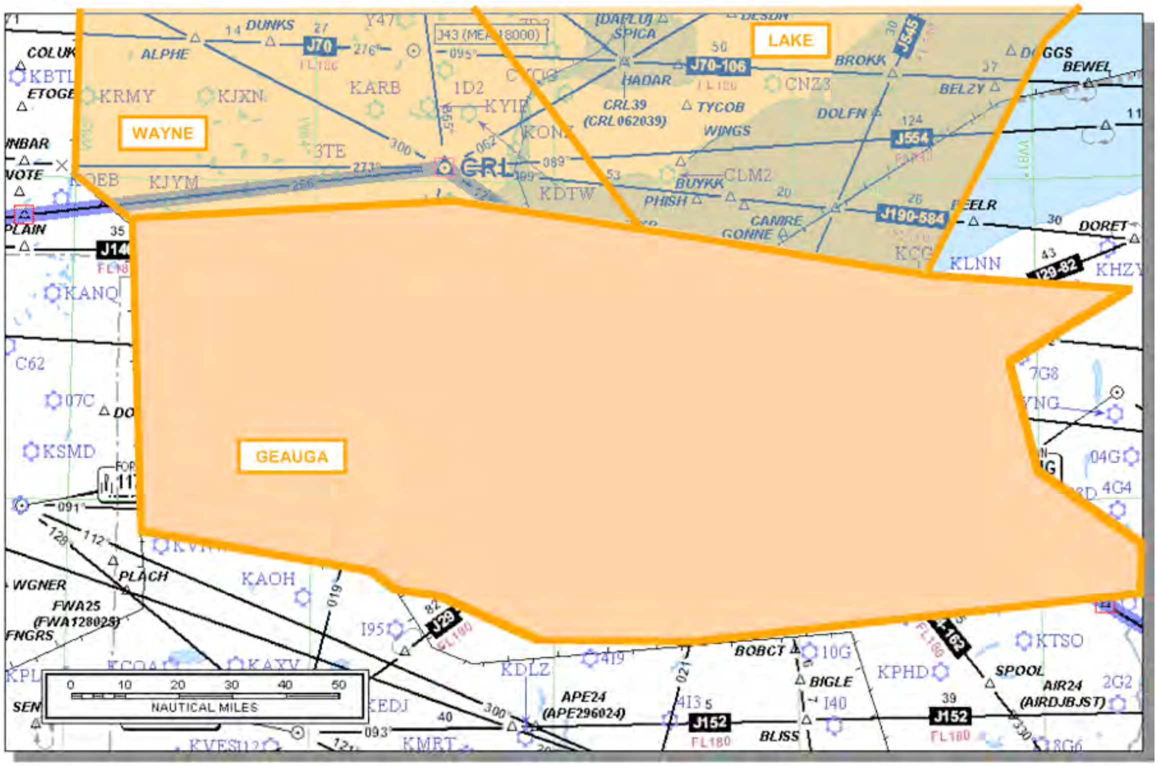
- Assumes GH @ 343 KTAS (5.72 nm/min), Altair @ 290 KTAS (3.17 nm/min), constant airspeeds, at same Flight Level
- Assumes both aircraft arrive at PROTN waypoint, just south of ZOB southern boundary, at the same time

Altair Crossing Waypoint …	Distance to PROTN	Minutes to PROTN	GH distance behind Altair
COHOW	176	55.6	142
WP1	132	41.7	106
WP2	107	33.8	86
DJB	82	25.9	66
PROTN	0	00.0	0

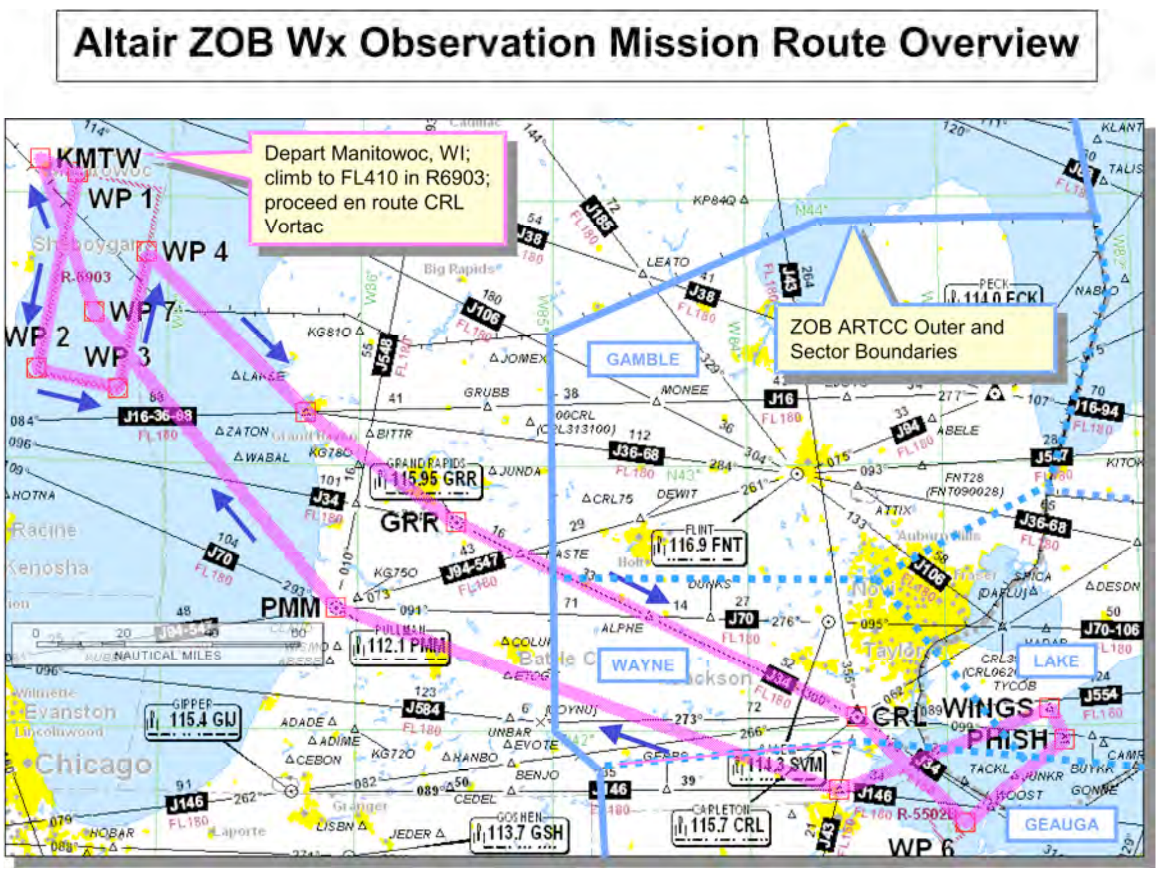
OF-2: Notional JUCAS Overflight Mission in ZOB Airspace



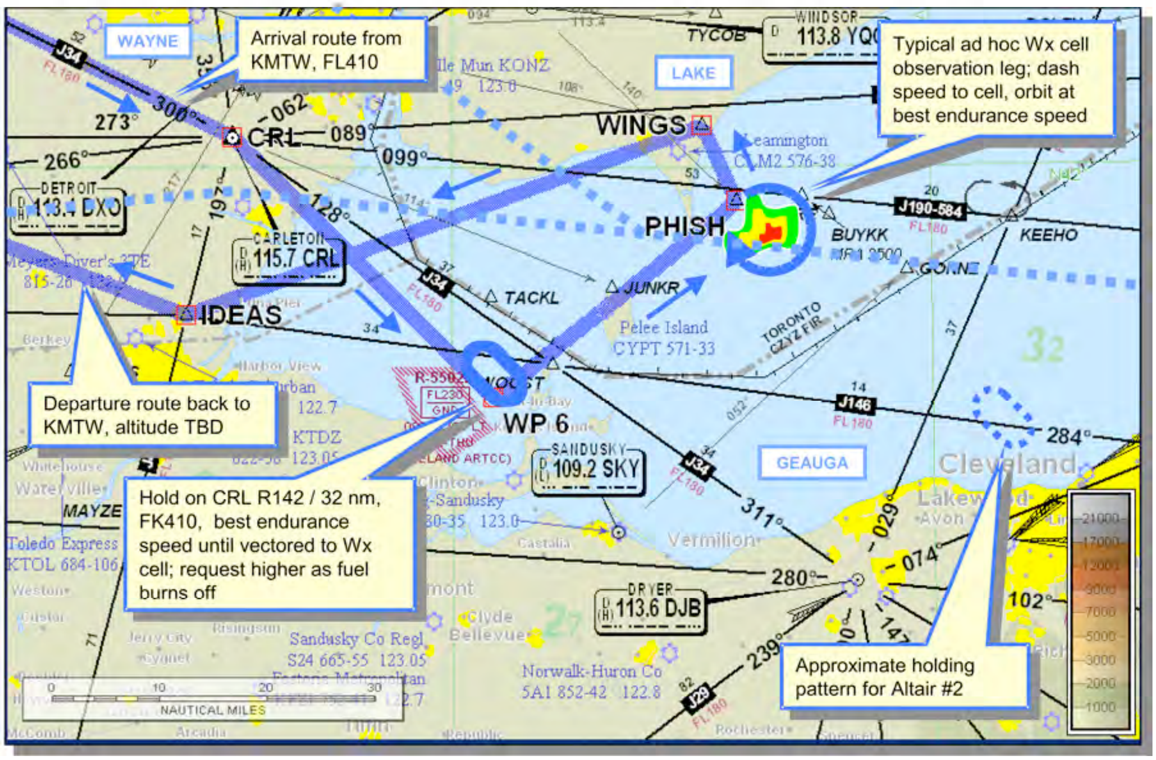
J-UCAS #2 Overflight Route
Diversion at DJB to Langley AFB



AL-1 and AL2: Altair High-Altitude Wx Observation Mission in ZOB Airspace (Cross-Country Ingress and Egress)



Altair ZOB Area Tstorm Observation Route Detail



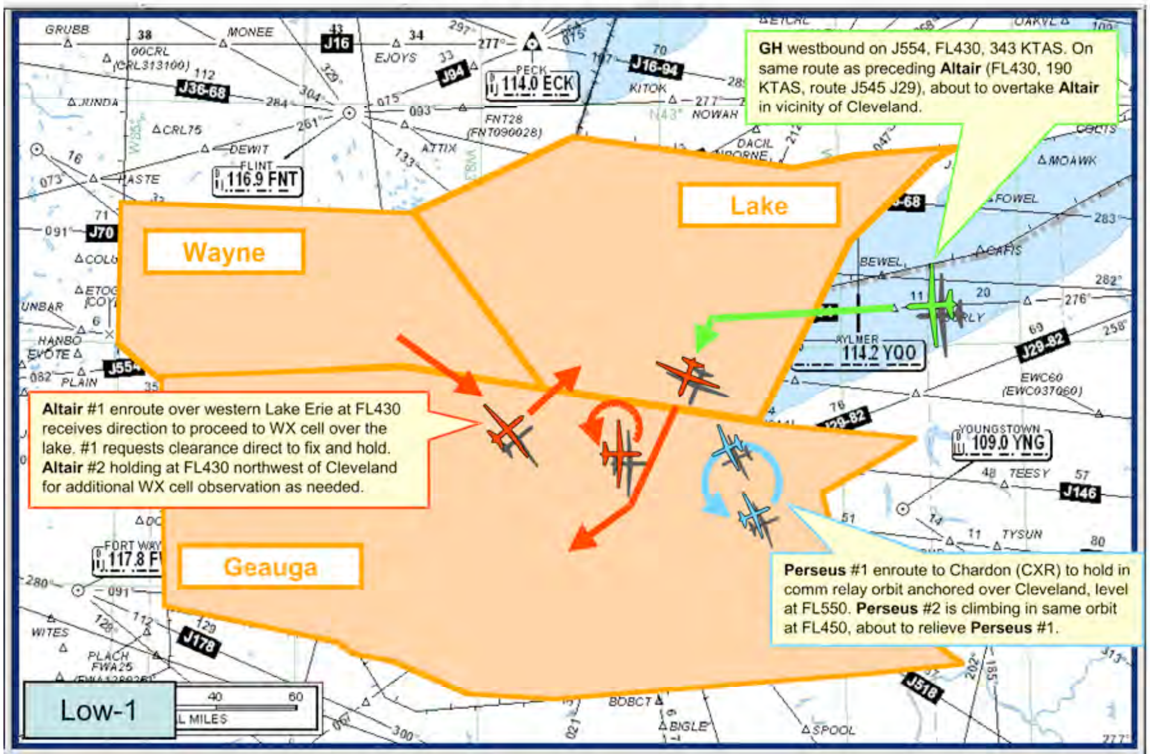
Altair Important Mission Waypoints

Altitude: FL410-510, No Wind

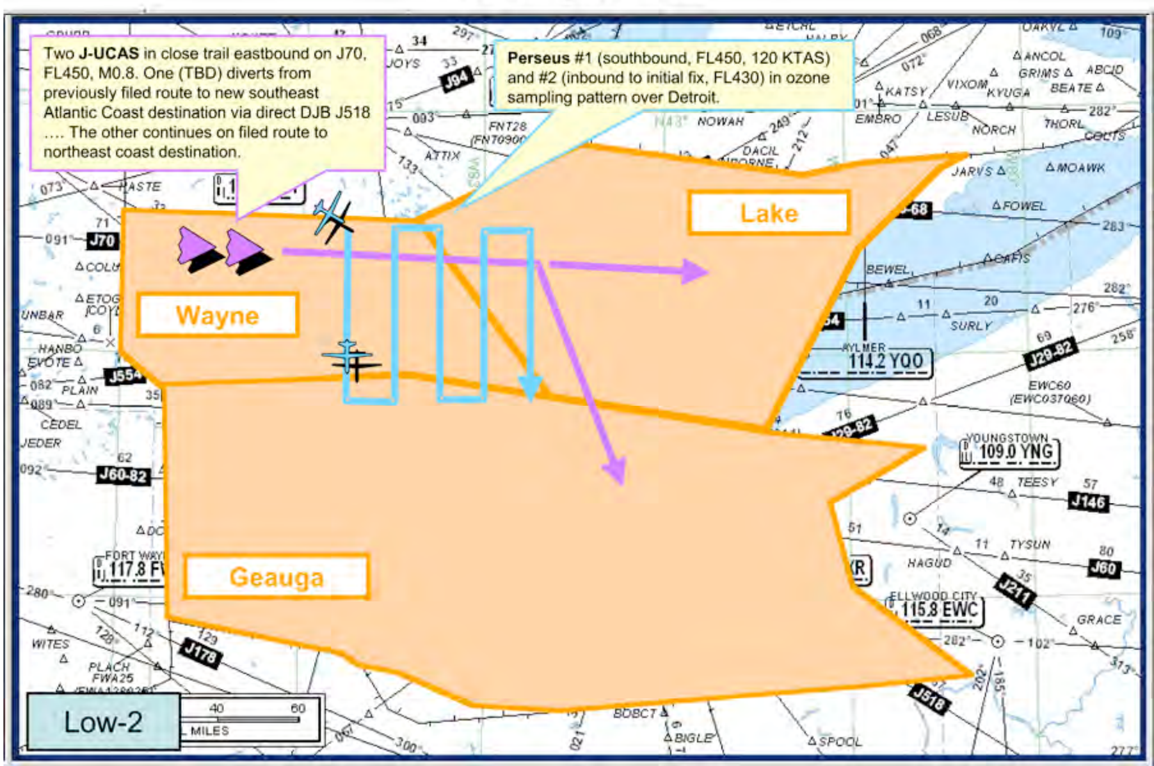
Location	Mag Crs (deg)	Gnd Spd (kts)	Dist / Total (nm)	Time / Total (min)
KMTW (Manitowoc County); Depart & climb in R6903 to FL410				
	South-east	V_y	365	1:22
CRL [Carleton] via dir DABJU dir GRR J34				
	142	190	63.6	0:25
WP6 [N 41° 38.6', W 082° 54.7']				
	142/322	190	variable	10 min per orbit
Holding Pattern Anchor Point; Hold until sensor operator detects storm cell within clearance area, request clearance dir to fix				
	058	190	29	0:10
PHISH [example]; Observation Waypoint; Orbit cell of interest for sensor observation, best loiter speed				
	As Reqd	As Reqd	As Reqd	As Reqd
Repeat as reqd for duration of mission; Request higher FL when able				
	North-west	190	415	1:32
Return via dir IDEAS dir PMM dir R6903, descend and land KMTW				

Appendix B: Normal AOS Scenarios

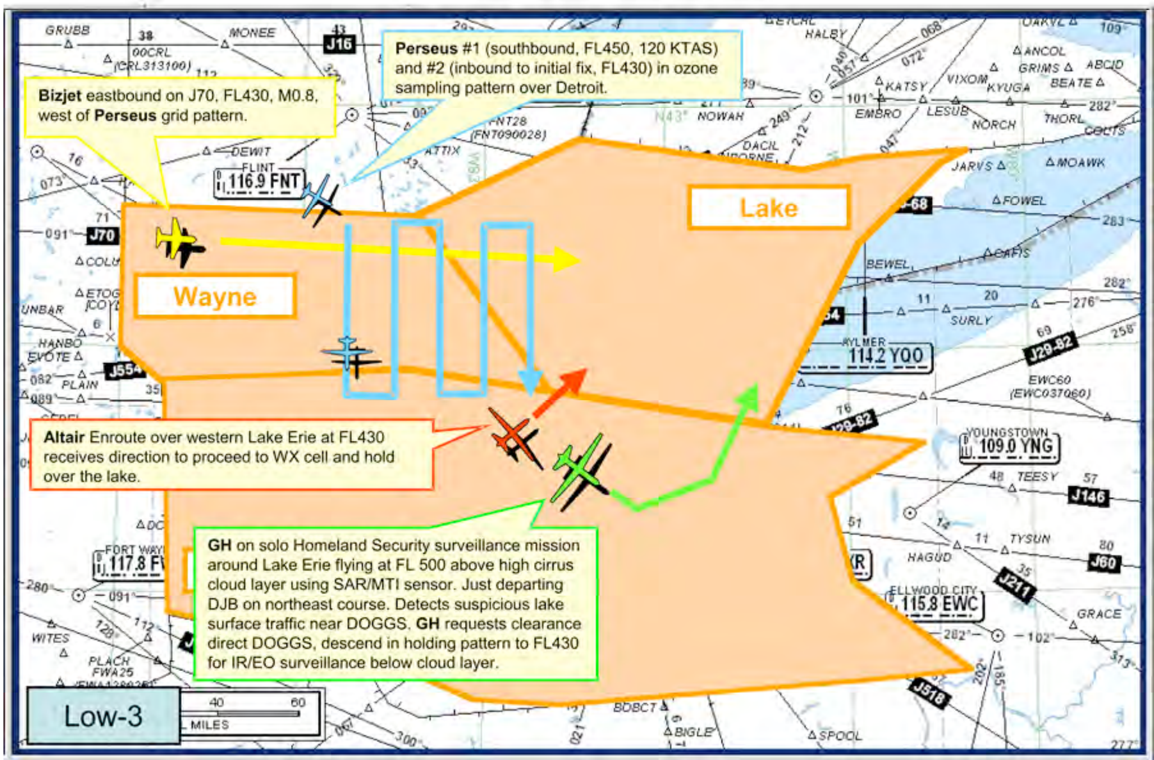
Scenario #1: Altair WX + GH/Altair Overflight/Overtake + Perseus Comm Relay Swap



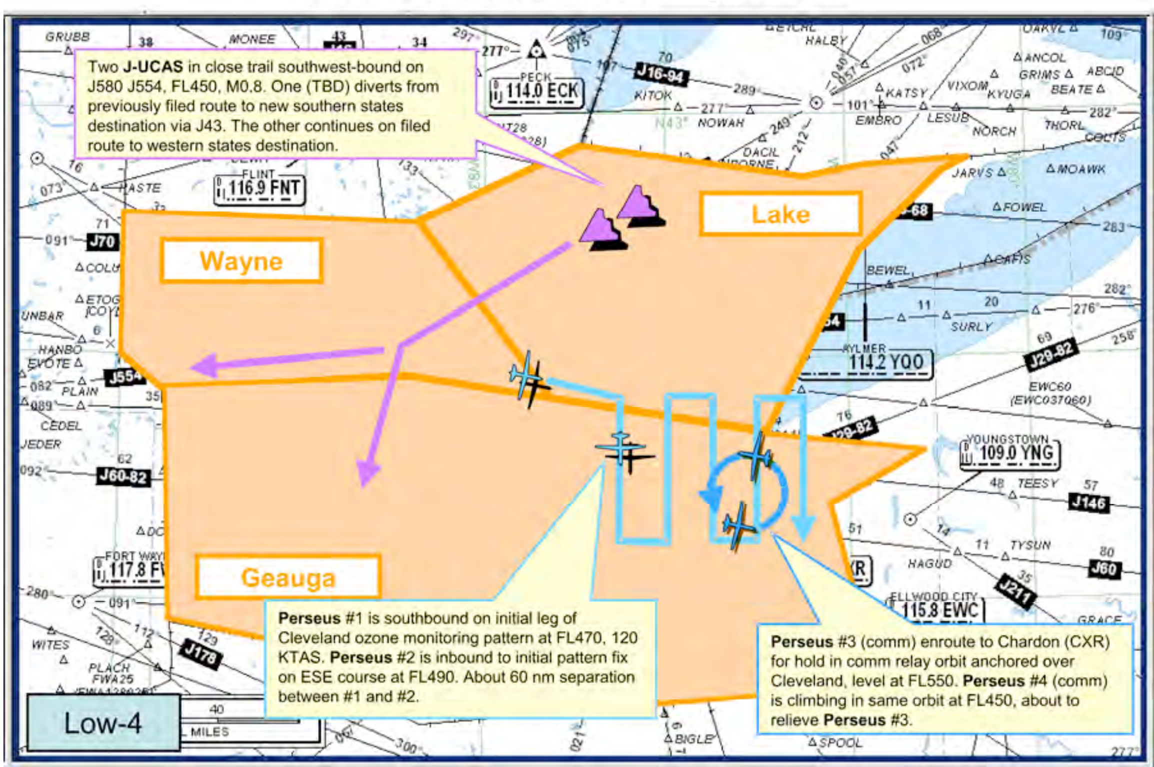
Scenario #2: Perseus Ozone Detroit + J-UCAS Eastbound Overflight/Divert



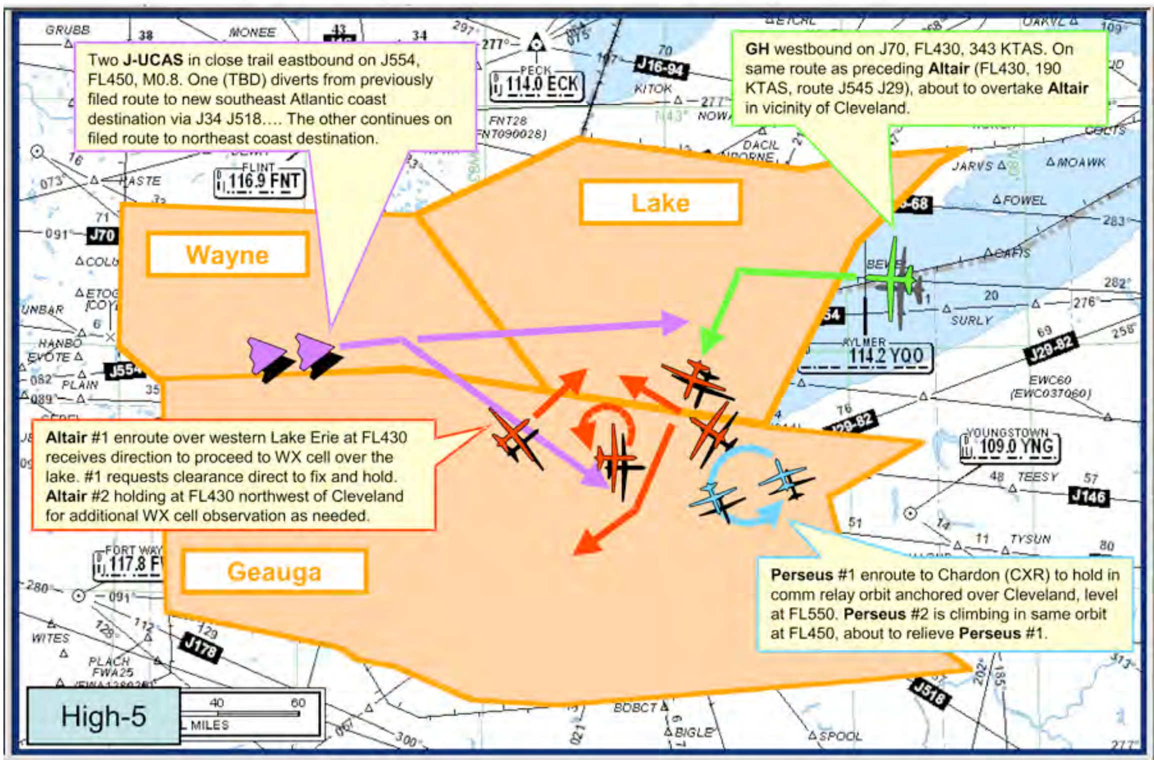
Scenario #3: Perseus Ozone Detroit + Business Jet Overflight +Altair WX + GH Solo Surveillance



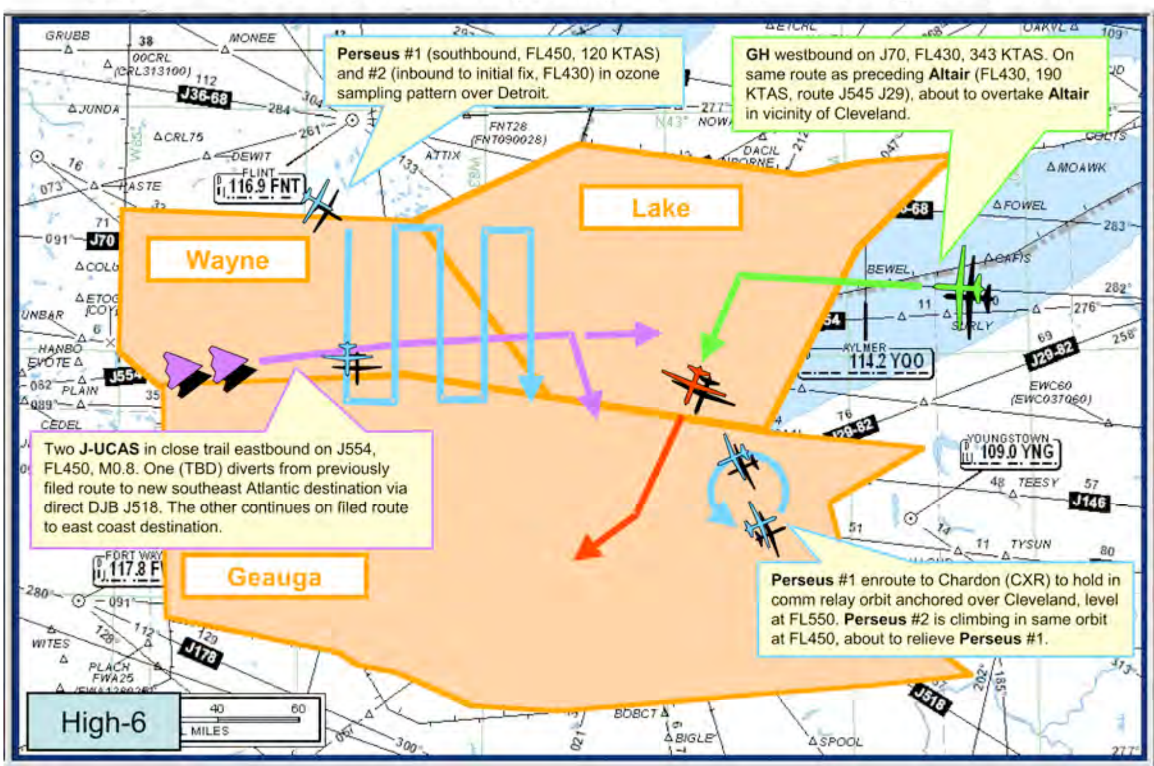
Scenario #4: Perseus Ozone Cleveland + Perseus Comm Relay Swap + Westbound J-UCAS Overflight/Divert



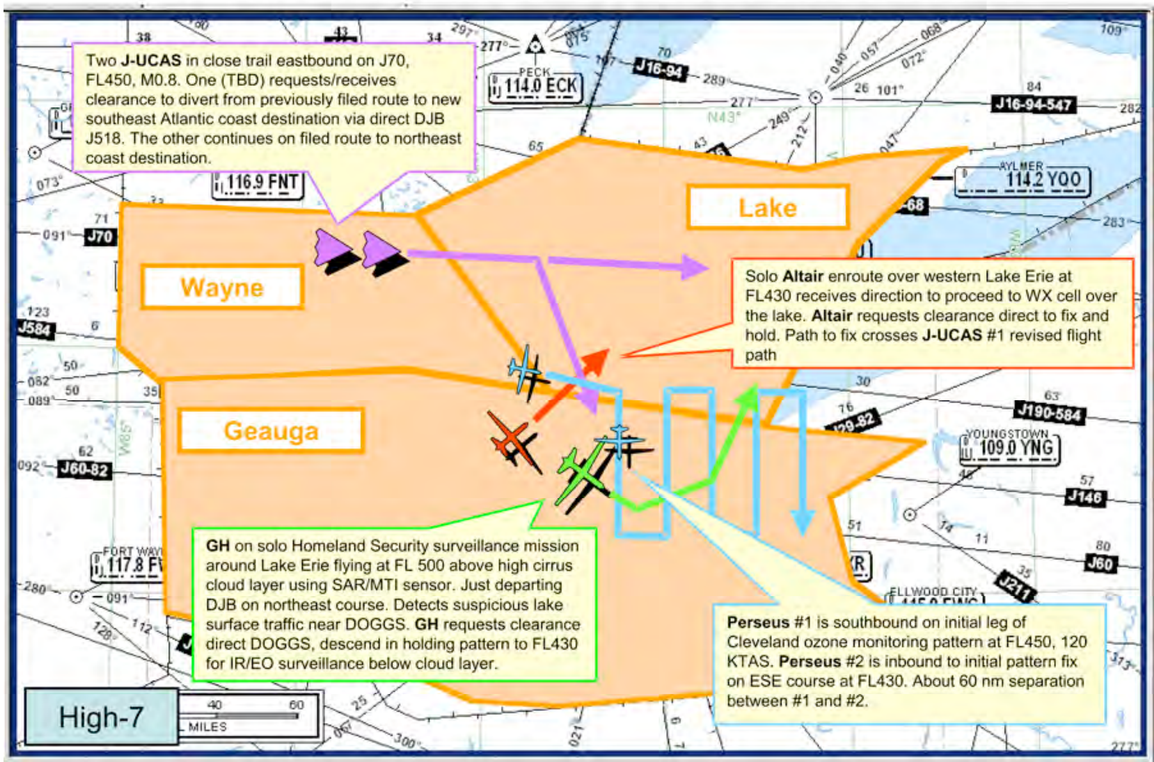
Scenario #5: Altair WX + J-UCAS Eastbound Overflight/Divert + Perseus Comm Relay Swap + GH/Altair Overflight/Overtake



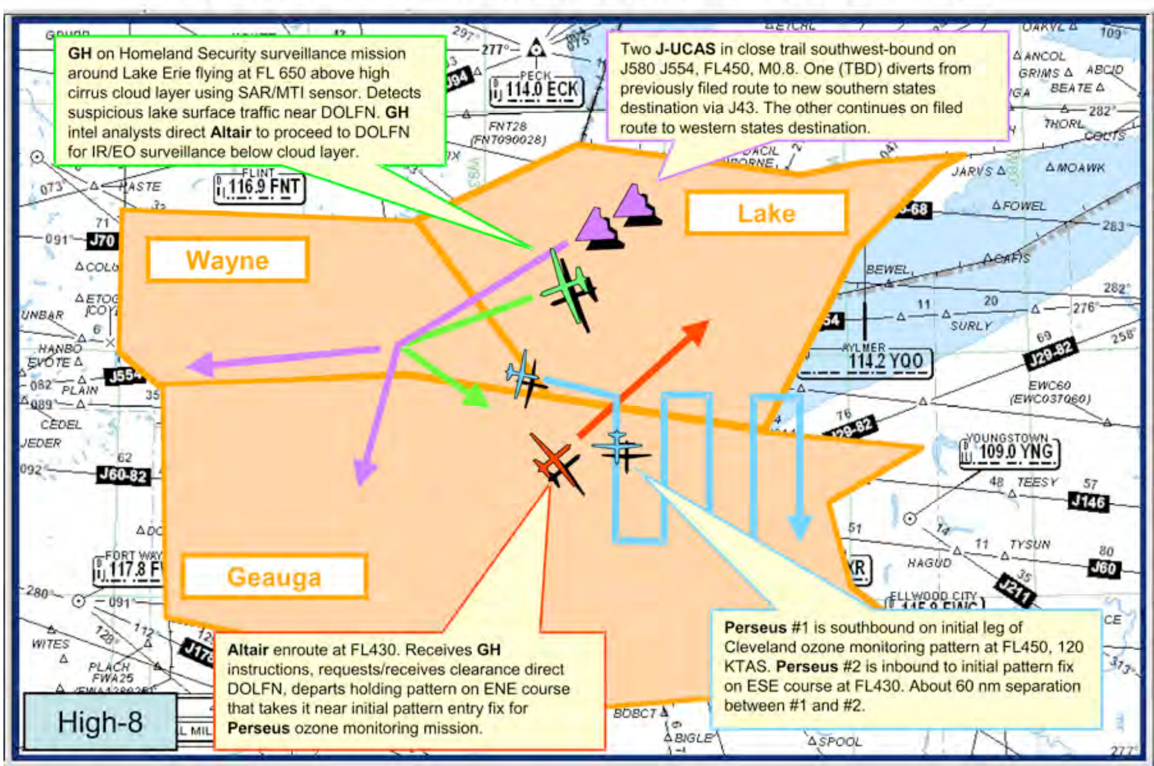
Scenario #6: J-UCAS Eastbound Overflight/Late Divert + Perseus Detroit Ozone + Perseus Comm Relay Swap + GH/Altair Overflight/Overtake



Scenario #7: Global Hawk Solo Surveillance + Altair WX + J-UCAS Eastbound Overflight/Late Divert +Perseus Cleveland Ozone

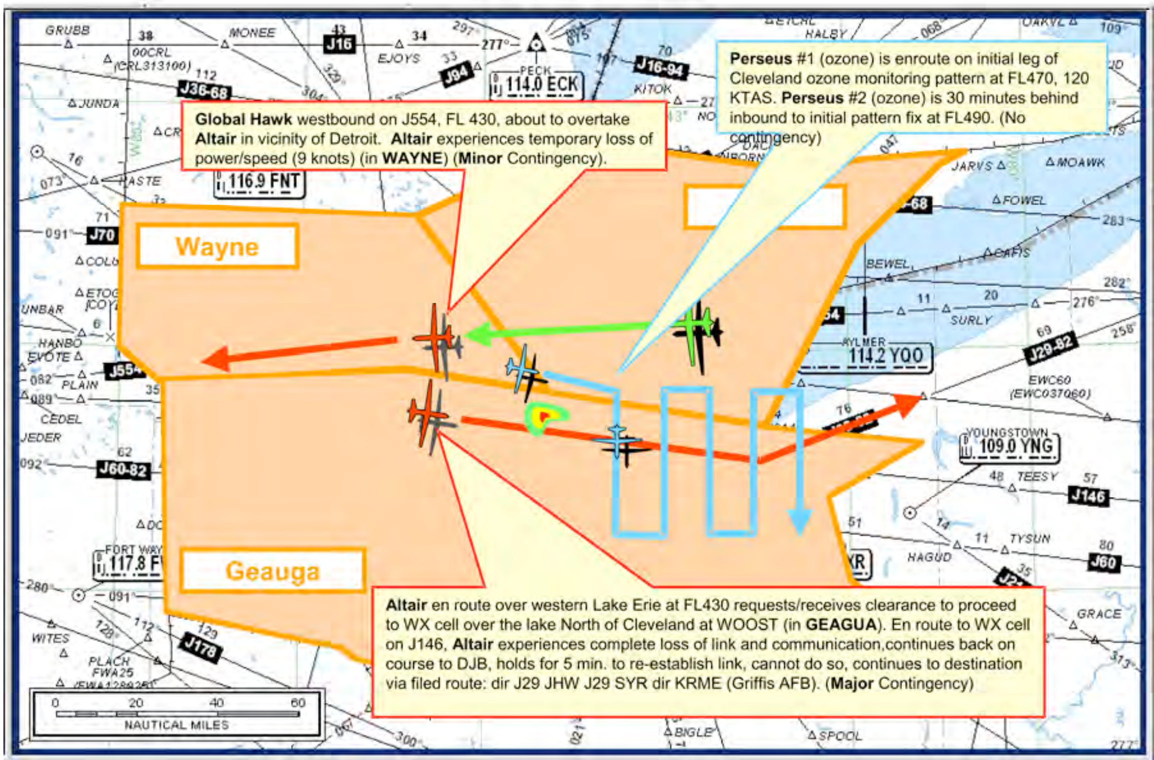


Scenario #8: Global Hawk & Altair Homeland Security + Perseus Ozone Cleveland + J-UCAS Westbound Overflight/Divert



Appendix C: Contingency Management AOS Scenarios

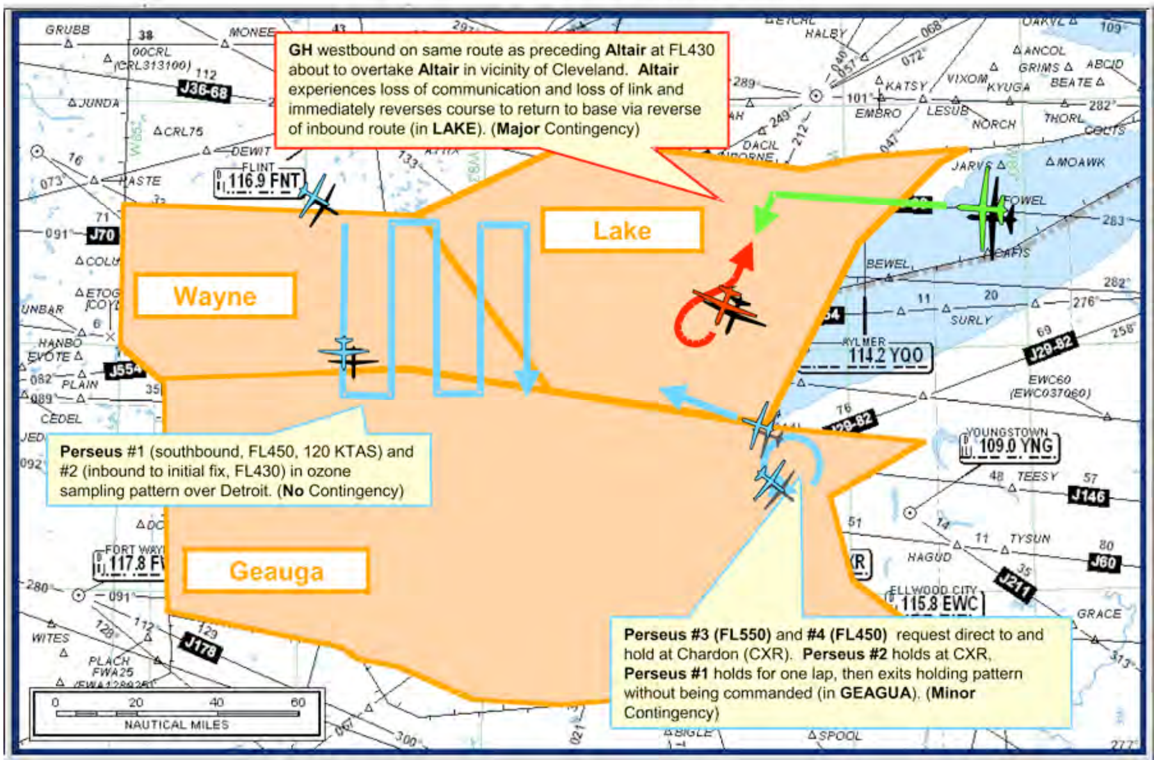
Sept AOS Session #1: Altair WX + GH/Altair Overtake + Perseus Cleveland Ozone



Sept AOS Session 1: Contingency Modifications from July AOS

- Global Hawk/Altair Overtake (**Minor** Contingency)
  - Leading Altair experiences temporary loss of engine power leading to reduced speed but maintains altitude
  - Time of lost power (22 min.) and speed difference (9 knots)
  - Should lead to faster overtake by following Global Hawk
- Altair Wx monitor requests/receives clearance to proceed to fix (WOOST) within Geauga Sector north of Cleveland) (**Major** Contingency)
  - While en route to Wx WOOST approximately on J146, Altair experiences complete loss of two-way voice communications and data link (both up- and down-links)
  - Automated response to lost link is for Altair to follow original post-mission recovery flight plan to nearest fix on route (DJB) and hold for 5 minutes to re-establish link. Cannot do so, so continues on to destination airport.
  - Assumed recovery flight plan from point of failure is: east via J146 DJB J29 JHW J29 SYR direct KRME (Rome AFB, NY)
- Perseus B Cleveland Ozone Monitoring Mission added for balance (**No** Contingency)
  - May interact with Altair on its automatic proceed-to-recovery-base route.

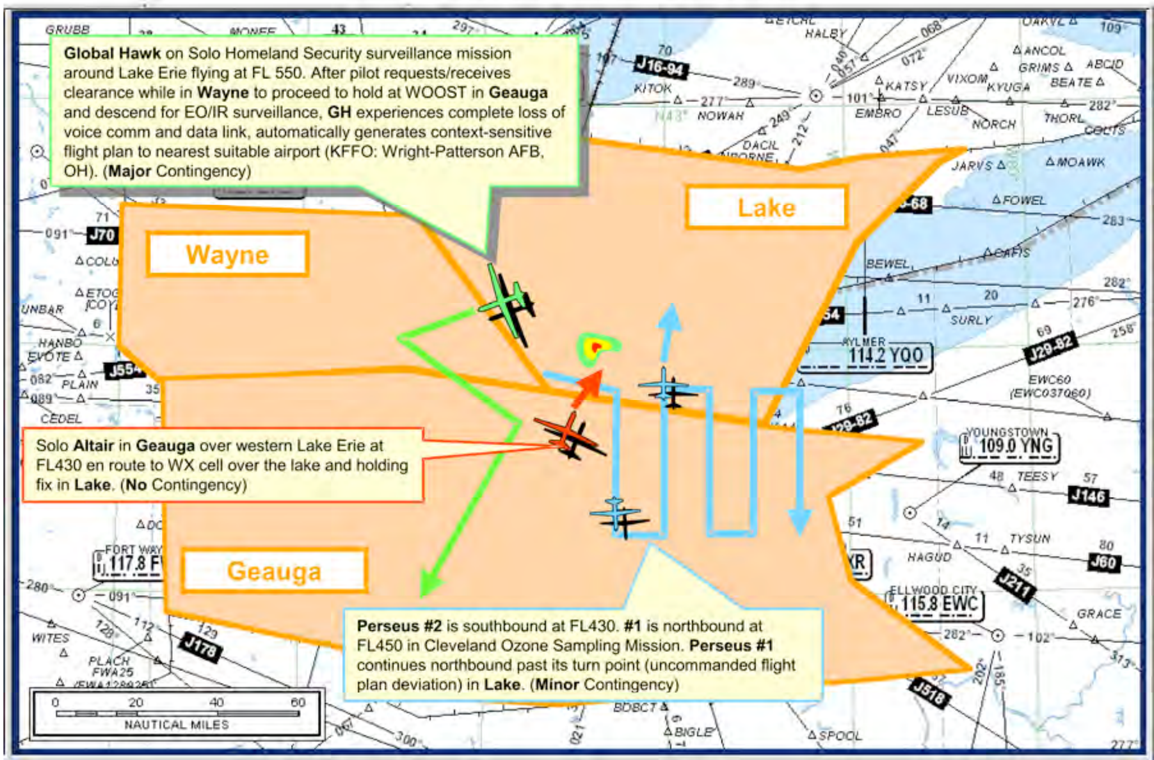
Sept AOS Session #2: Perseus Ozone Detroit Overflight + GH/Altair Overtake +Perseus Comm Relay



Sept AOS Session 2: Contingency Modifications from July AOS

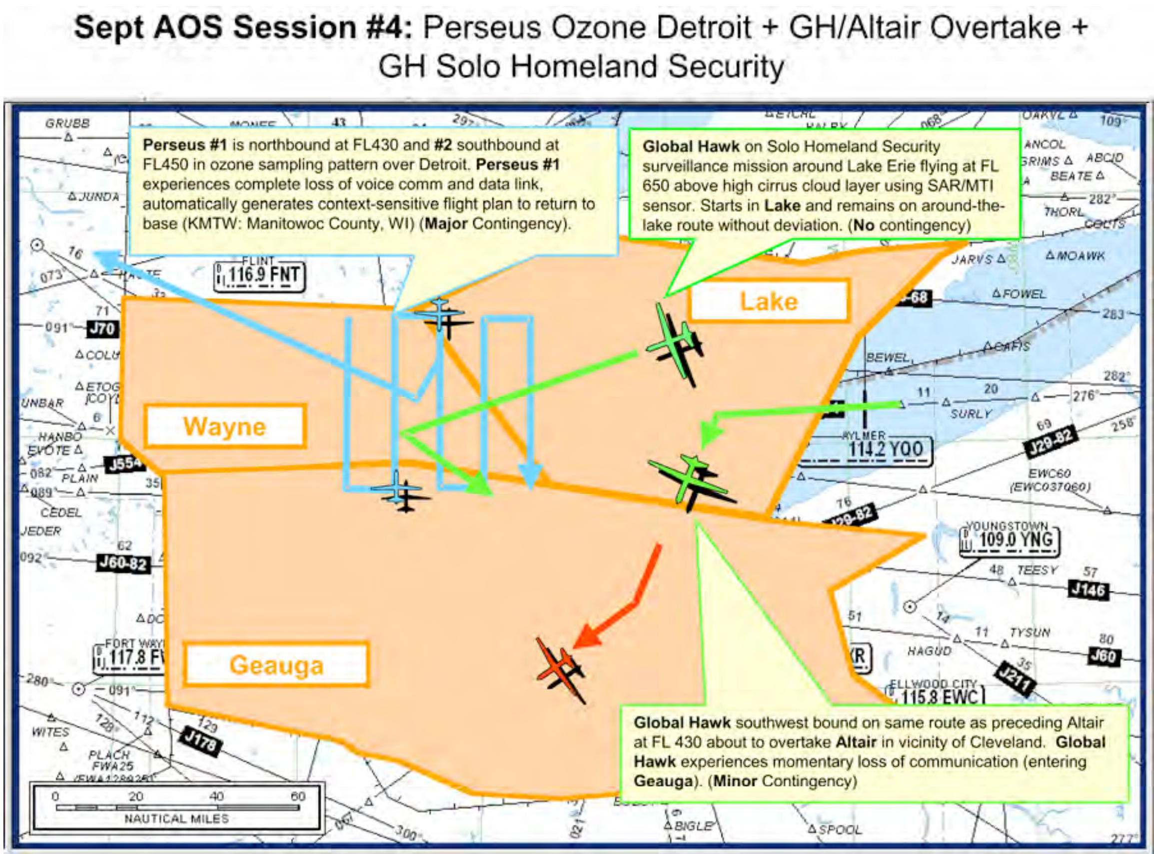
- Global Hawk/Altair Overtake (**Major** Contingency):
  - Leading Altair experiences unrecoverable loss of 2-way comm and 2-way data link while southwest bound in Lake Sector
  - Altair automatically reverts to simplest return-to-base plan:
    - Reverse current course via 30° teardrop.
    - Fly ingress route (waypoints, jet routes) in reverse order to return to point of origin (KRME: Griffis AFB, NY) BROKK COHOW JHW SYR RME.
  - Places Altair in path of inbound Global Hawk
- Perseus B Communication Relay Swapout (**Minor** Contingency):
  - Perseus #1 and #2 enter holding pattern at Chardon
  - After one lap around holding pattern, Perseus #1 wanders off on northwest course heading 310(departs holding pattern)
  - Recoverable when noted by controller (pseudopilot does not voluntarily assist, i.e., “plays dumb”)
- Perseus B Detroit Ozone Monitoring mission (**No** Contingency)

Sept AOS Session #3: Solo Global Hawk Homeland Security + Altair Wx + Perseus Ozone Cleveland



Sept AOS Session 3: Contingency Modifications from July AOS

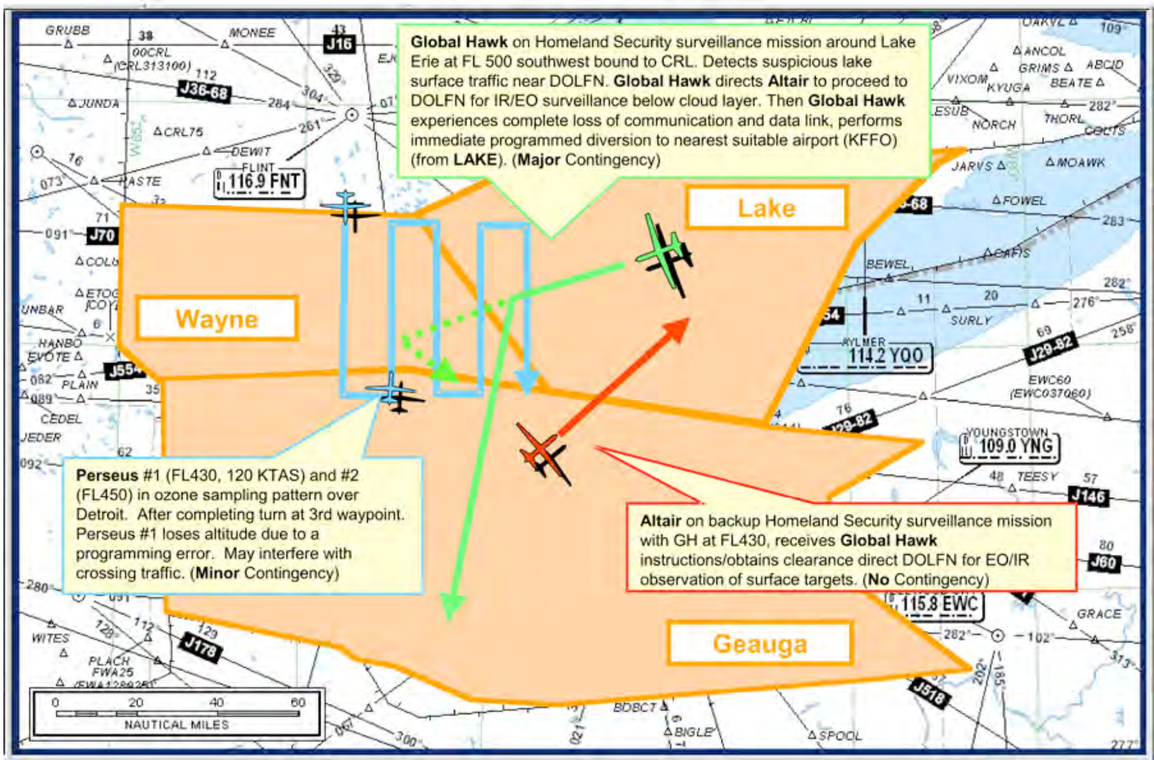
- Global Hawk Solo Homeland Security Mission (**Major** Contingency):
  - GH inbound to CRL VOR at FL550 completing a lap around Erie surveillance route, detects suspicious lake surface traffic in Geauga Sector
  - While in Wayne Sector, requests/receives clearance to fly to WOOST intersection, descend in holding pattern to FL430 for EO/IR imaging
  - During descent, GH experiences total voice comm and data link failure.
  - Onboard algorithms calculate context-sensitive off-airways route to nearest suitable airport (KFFO: Wright-Patterson AFB, OH) and GH initiates departure from WOOST on southwest course (direct) to KFFO. DJB JHW BUF CRL JOT IOW OFF.
- Perseus B Cleveland Ozone Monitoring Mission (**Minor** Contingency):
  - Perseus #1 on northbound leg of grid pattern at FL450, fails to turn eastbound at planned waypoint, instead continues on north heading over Lake Erie
  - Recoverable when noted by controller (pseudopilot does not voluntarily assist, i.e., “plays dumb”)
  - Perseus #2 is 30 minutes behind #1 in grid pattern and performs normally
- Altair Wx Mission added for balance (**No** Contingency)



Sept AOS Session 4: Contingency Modifications from July AOS

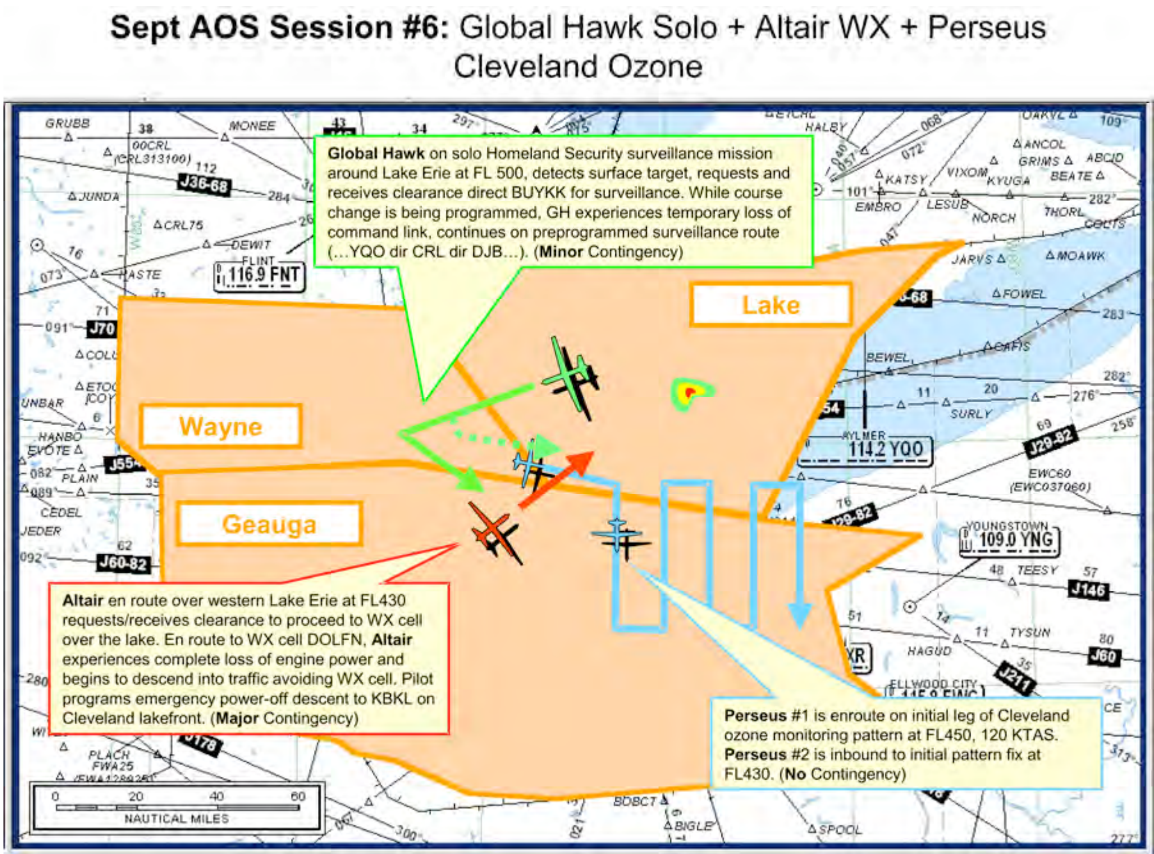
- Global Hawk/Altair Overtake Mission (**Minor** contingency):
  - Just as GH enters Geauga Sector from Lake, it experiences a brief loss of communications
  - May affect handoff from Lake to Geauga; may affect controllers' response to overtake situation. Spontaneous recovery (time 7 min.)
- Perseus B Detroit Ozone Monitoring Mission (**Major** Contingency):
  - Perseus #2 on southbound leg of grid pattern at FL450 performs normally
  - Perseus #1 is 30 minutes ahead #2 northbound in grid pattern; experiences complete loss of voice comm and data link
  - Onboard algorithms calculate context-sensitive off-airways route to return to base (KMTW: Manitowoc County, WI) and initiates departure from grid pattern on west-northwest course (direct) to KMTW.
- Global Hawk Solo Surveillance Mission (**No** Contingency)
  - GH remains at surveillance altitude on planned around-the-lake route (… YQO dir CRL dir DJB …)

Sept AOS Session #5: Global Hawk/Altair Homeland Security + Perseus Ozone Cleveland



Sept AOS Session 5: Contingency Modifications from July AOS

- Global Hawk/Altair Homeland Security Mission (**Major** contingency):
  - GH on route leg YQO dir CRL in Wayne, detects suspicious surface traffic (radar), directs supporting Altair to proceed to DOLFN for EO/IR observation
  - Immediately thereafter, GH experiences complete loss of both comm and data link
  - GH immediately executes a pre-programmed direct diversion to nearest suitable airport (KFFO: Wright-Patterson AFB, OH) DIR MAYZE J43 ROD FFO.
- Perseus B Detroit Ozone Monitoring Mission (**Minor** Contingency):
  - Perseus #1 at FL430 preceeds Perseus #2 at FL 450 by 30 minutes.
  - Perseus #1 completes third waypoint turn and Programming errors have Perseus #1 descending to FL380.
  - Descending altitude brings Perseus in path of crossing NAS traffic.
  - Recoverable when noted by controller (pseudopilot does not voluntarily assist, i.e., “plays dumb”). Climb back up to FL430.
- Altair Cooperative Surveillance Mission with GH (**No** Contingency)
  - Request Direct and Hold at DOLFN.



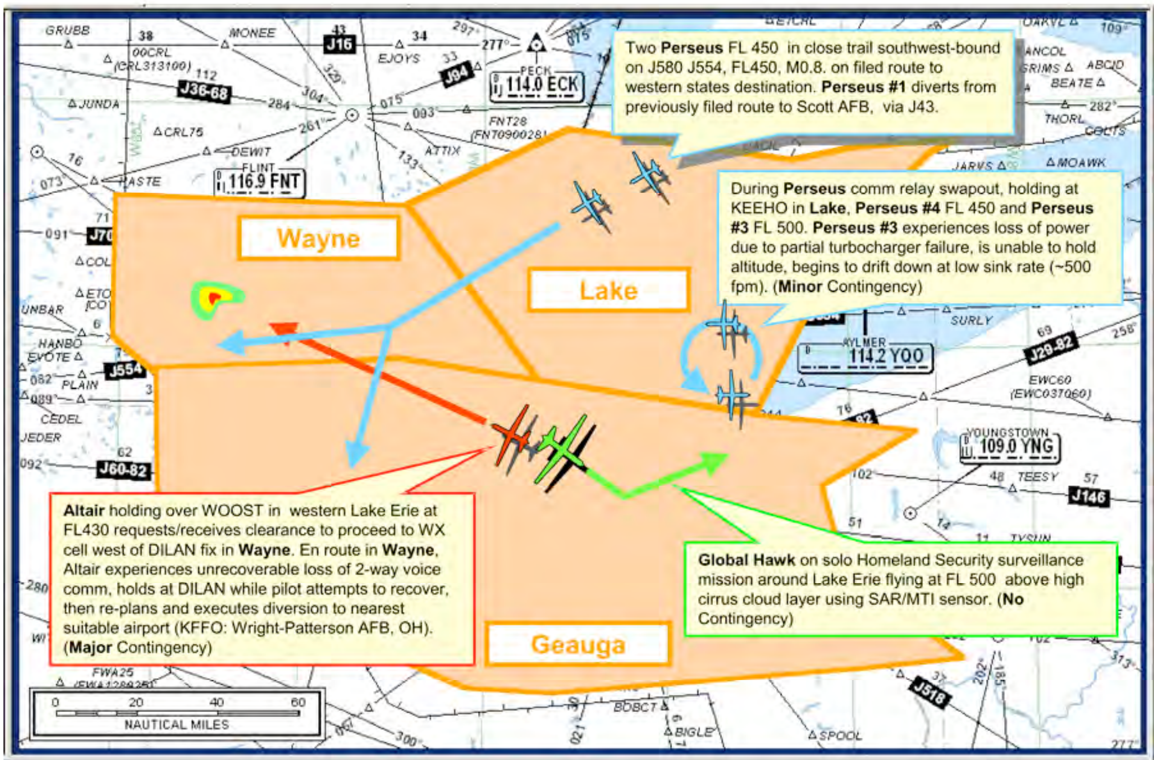
Sept AOS Session 6: Contingency Modifications from July AOS

- Global Hawk Solo Homeland Security Mission (**Minor** contingency):
  - GH on route leg YQO dir CRL in Wayne, detects suspicious surface traffic (radar), requests/receives clearance direct BUYKK for EO/IR observation
  - Immediately thereafter, GH experiences temporary loss of data link, is unable to follow last clearance to BUYKK
  - GH continues on around-the-lake route (… YQO dir CRL dir DJB …) for 5 minutes, then link is recovered and GH re-requests last clearance.
  - GH pilot probably should coordinate with controller to advise of link loss (?)

- Altair Wx Observation Mission with GH (**Major** Contingency):
  - Altair requests/receives clearance direct to cell at DOLFN in Lake Sector, begins flight to cell at FL430
  - En route in Geauga/Lake, Altair experiences loss of engine power to idle. Automatic response is to reduce speed to best L/D and descend at resulting vertical speed (less than 1,000 fpm?); danger of descending into traffic. Unrecoverable; pilot should advise ATC and reprogram lateral route for unpowered descent and landing at airport within gliding distance (KBKL: Burke Lakefront, Cleveland) DIR BUYKK FUVEN BKL. With a power off descent while holding at FUVEN, until handed off to lower altitude sector.

- Perseus B Detroit Ozone Monitoring Mission (**No** Contingency):

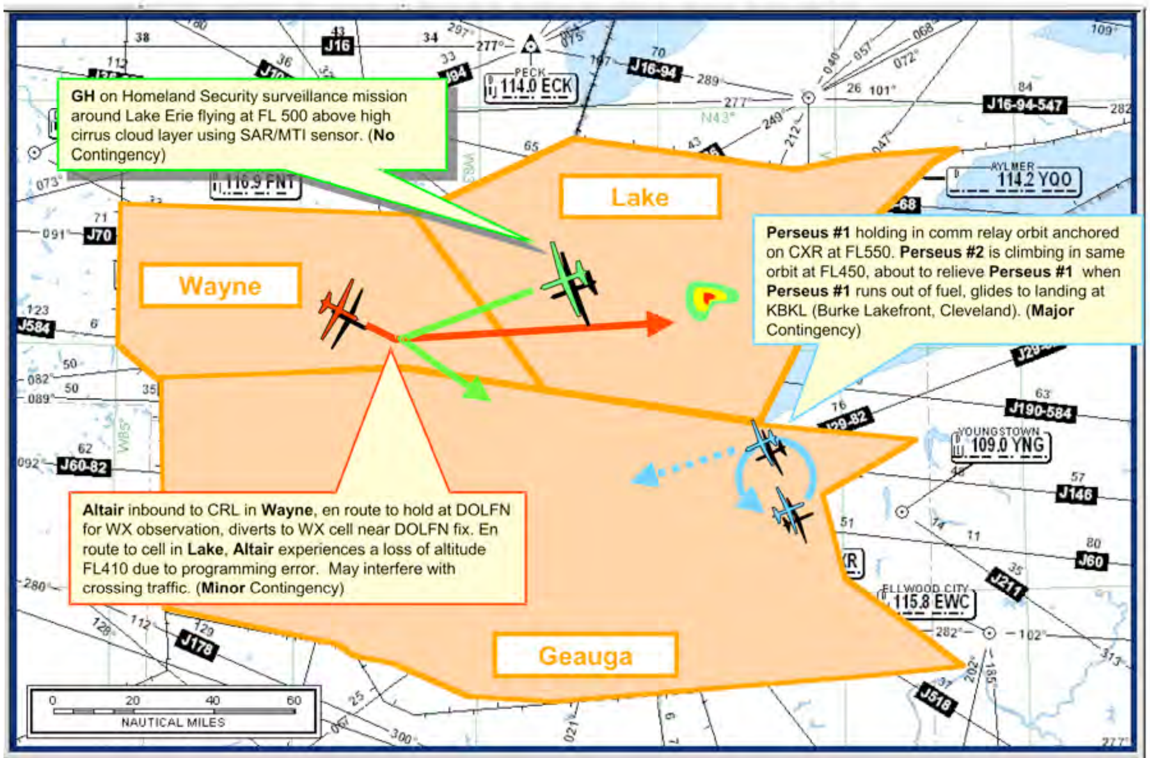
Sept AOS Session #7: Altair WX + Perseus Comm Relay Swap + Global Hawk Solo Homeland Security + Perseus Overflight



Sept AOS Session 7: Contingency Modifications from July AOS

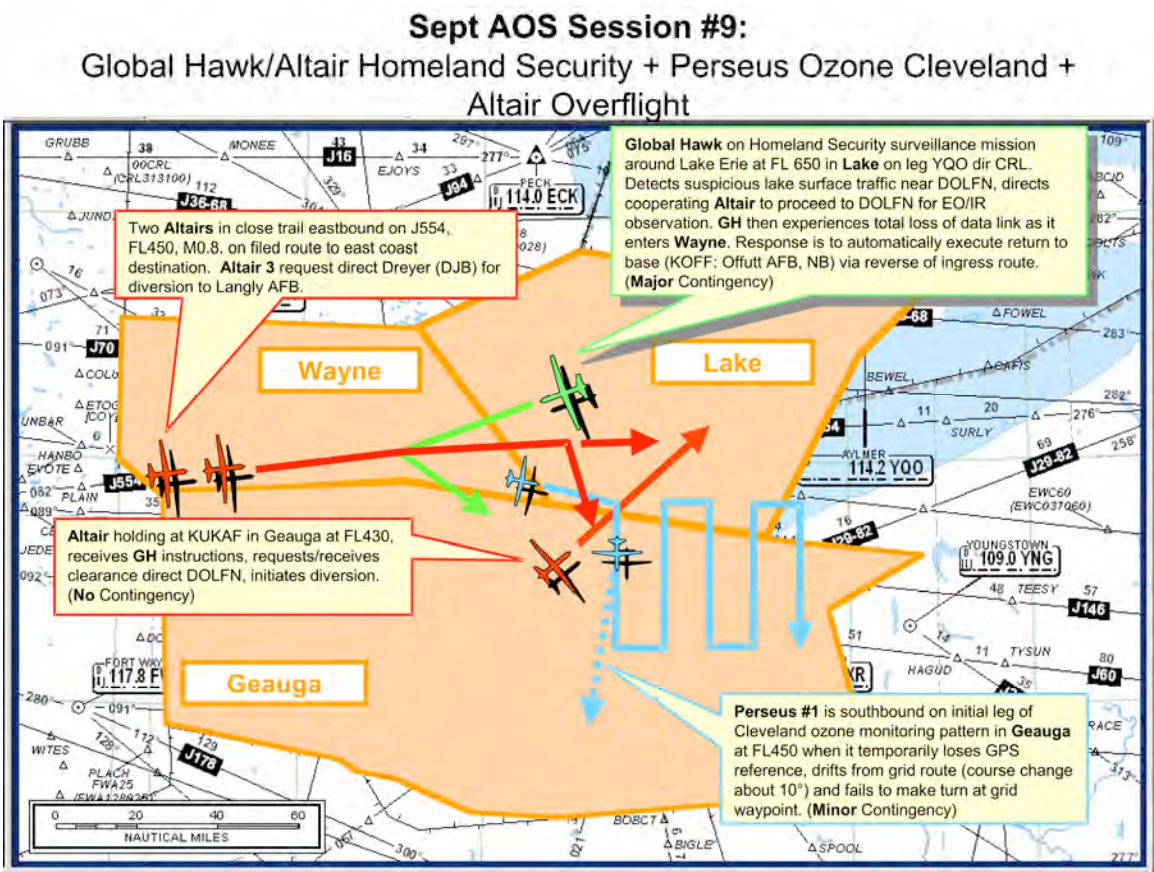
- Altair Wx Observation Mission (**Major** Contingency):
  - Altair requests/receives clearance direct to Wx cell in Wayne Sector west of DILAN fix, begins flight to cell at FL430
  - En route in Wayne, Altair experiences loss of 2-way voice communications.
  - Pilot's response is to enter holding pattern at DILAN (e.g., hold on CRL R289) while attempt is made to recover comm (6 min. TBD)
  - When unable to recover, pilot replans (or invokes stored flight plan) for diversion to nearest suitable airport (KFFO: Wright-Patterson AFB, OH) DIR ROD BLV.
- Perseus B Communications Relay Swapout Mission (**Minor** Contingency):
  - Holding at KEEHO intersection
  - Perseus #3 at higher altitude (FL500) experiences partial turbocharger failure and is unable to hold altitude (no effect on ability to maintain course in holding pattern)
  - Perseus #3 begins to drift down from cleared altitude at low rate (~500 fpm)
  - Remaining turbocharger capacity is sufficient to prevent altitude loss below FL400, so Perseus #3 can remain in holding pattern (therefore not a major contingency)
- Global Hawk Solo Homeland Security Mission (**No** contingency):
  - GH on route leg … CRL dir DJB dir JHW … in Geauga Sector.
- ADDED Perseus B Overflight (Diversion)
  - Same as July Sceanrio #8 J-UCAS but Perseus instead. To demonstrate overflight of Perseus type aircraft.
  - Perseus #1 receives directions to divert to Scott AFB, after entering Wayne at CRL.

Sept AOS Session #8: Altair WX + Perseus Comm Relay Swap + Global Hawk Solo Homeland Security



Sept AOS Session 8: Contingency Modifications from July AOS

- Altair Wx Observation Mission (**Minor** Contingency):
  - Altair is still on ingress route in Wayne Sector, inbound to CRL, when it receives instructions to divert to Wx cell
  - Altair requests/receives clearance to proceed from over/near CRL direct to Wx cell in Lake Sector near DOLFN fix, begins flight to cell at FL430 on/near J554
  - Altair experiences a loss of altitude (FL410) due to programming error. Pilot play dumb and does not inform ATC. (could involve crossing traffic) recoverable, climb back to FL430 when ATC notices.
- Perseus B Communications Relay Swapout Mission (**Major** Contingency):
  - Perseus #1 and #2 in holding pattern anchored on CXR
  - Perseus #1 at higher altitude (FL550) experiences fuel exhaustion due to faulty fuel flow instrumentation (no effect on ability to maintain course in holding pattern)
  - Perseus #1 automated response is to adjust trim to glide at best L/D ratio (airspeed and sink rate per aero model)
  - Pilot declares emergency and programs aircraft to land at suitable airport within gliding distance (e.g., KBKL: Burke Lakefront, Cleveland)
- Global Hawk Solo Homeland Security Mission (**No** contingency):
  - GH on route leg … YQO dir CRL dir DJB … for EO/IR observation.

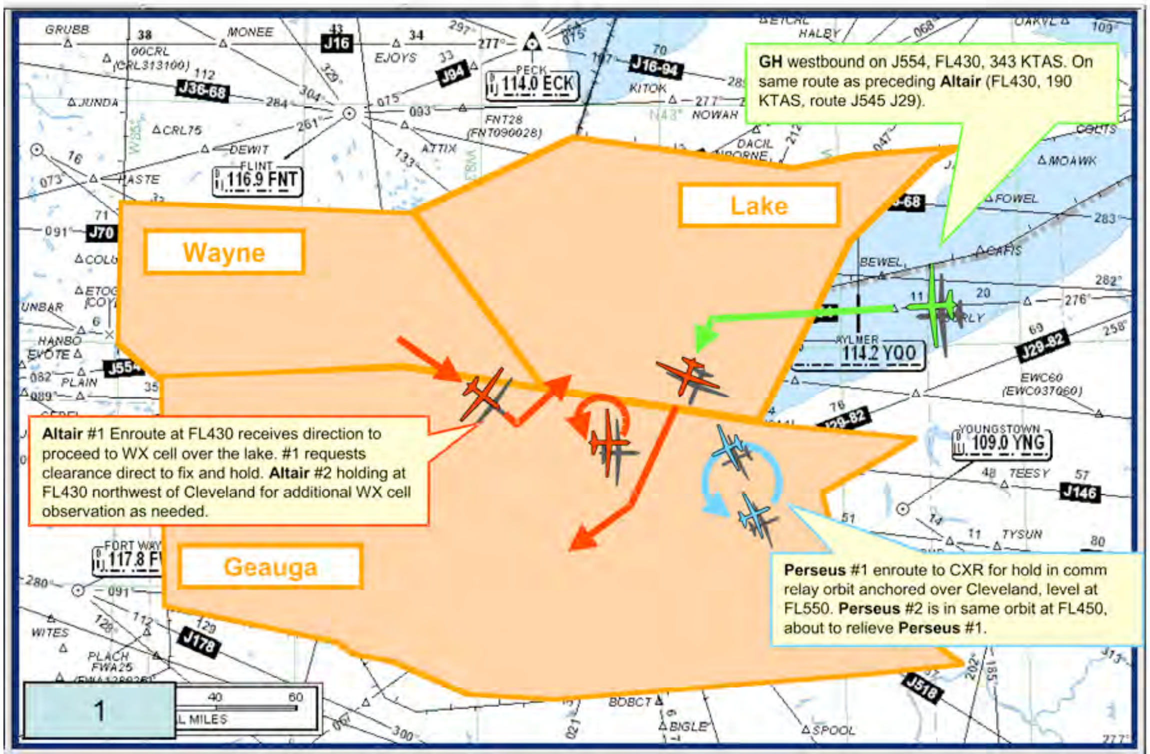


Sept AOS Session 9: Contingency Modifications from July AOS

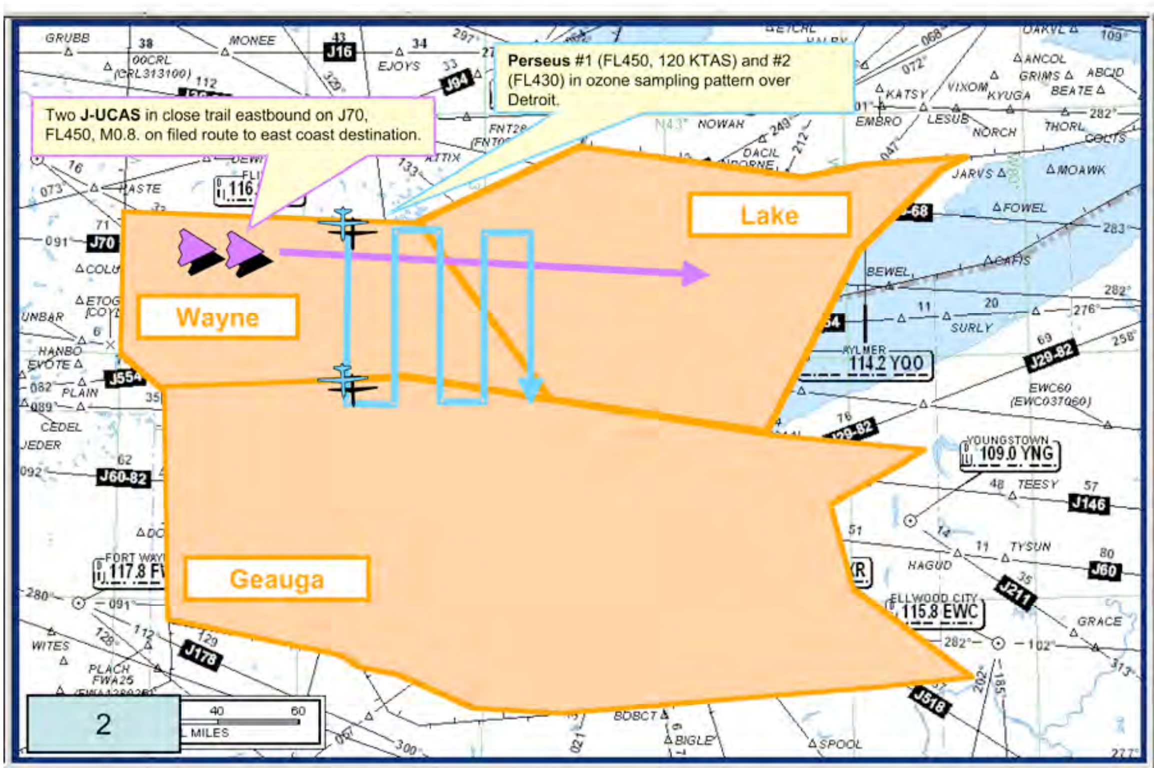
- Global Hawk Homeland Security Mission (**Major** contingency):
  - GH on route leg YQO dir CRL in Lake Sector, detects suspicious surface traffic (radar), directs cooperating Altair to go direct DOLFN for EO/IR observation
  - Immediately thereafter, GH experiences unrecoverable loss of data link, continues to track programmed route (inbound to CRL) into Wayne
  - Decision algorithm activates lost link contingency plan: immediate return via reverse of reress route to base of origin (KOFF: Offutt AFB, NB) DIR COYNU OBK DSM.
- Altair Cooperative Homeland Security Mission (with GH) (**No** contingency):
  - DIR DOLFN for security observations.
- Perseus B Detroit Ozone Monitoring Mission (**Minor** Contingency):
  - Perseus #1 southbound at FL450 in first leg of grid pattern in Geauga Sector as Perseus #2 is inbound on ingress route at FL430 to first grid waypoint in Lake Sector
  - Perseus #1 experiences a temporary loss of navigation sensor/system function (loss of GPS signal?), causing it to drift off course by about 10° and miss the eastbound turn point at the end of the leg (time of outage is TBD)
  - Recoverable if/when noted by controller and/or navigation system regains function (pseudopilot does not voluntarily assist, i.e., “plays dumb” or distracted)
- ADDED Altair Overflight (Diversion)
  - Same as July Sceanrio #6 J-UCAS but Altair instead. To demonstrate overflight of Altair type aircraft.
  - Altair #3 receives directions to divert to Langly AFB, after entering Wayne at CRL.

Appendix D: Normal AOS Controller Session Briefs

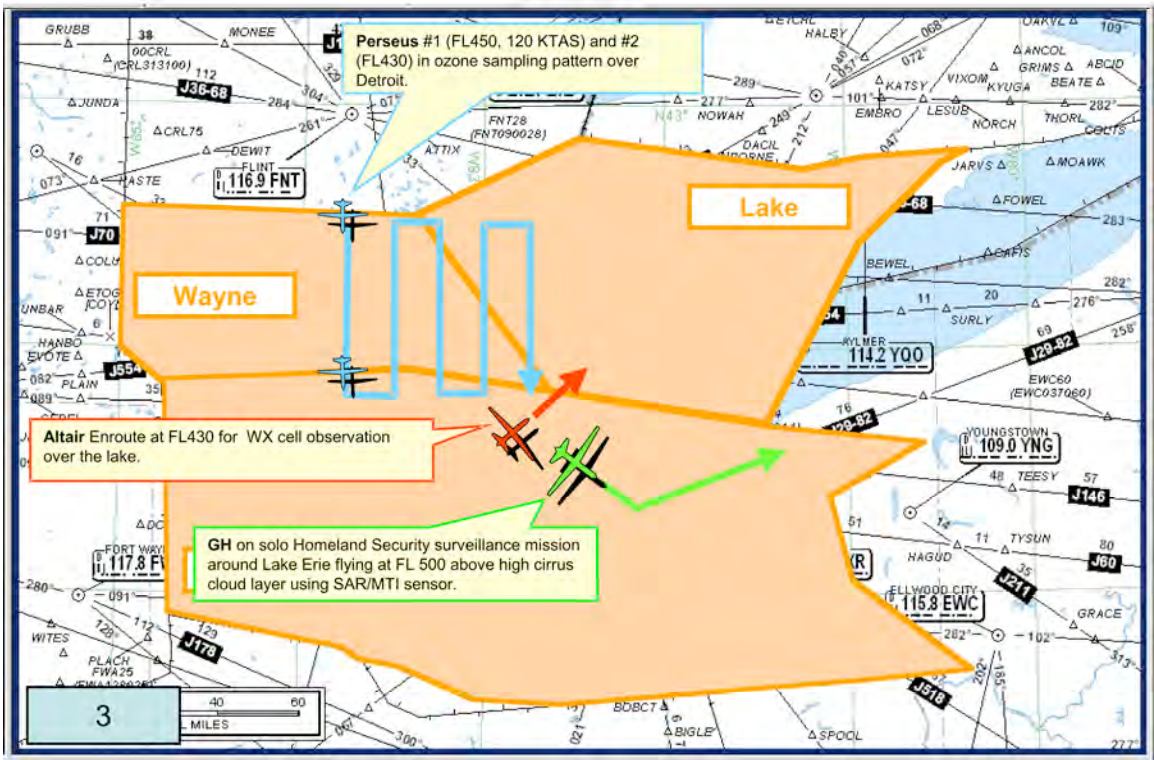
Scenario #1: Altair WX + GH/Altair Overflight + Perseus Comm Relay Swap



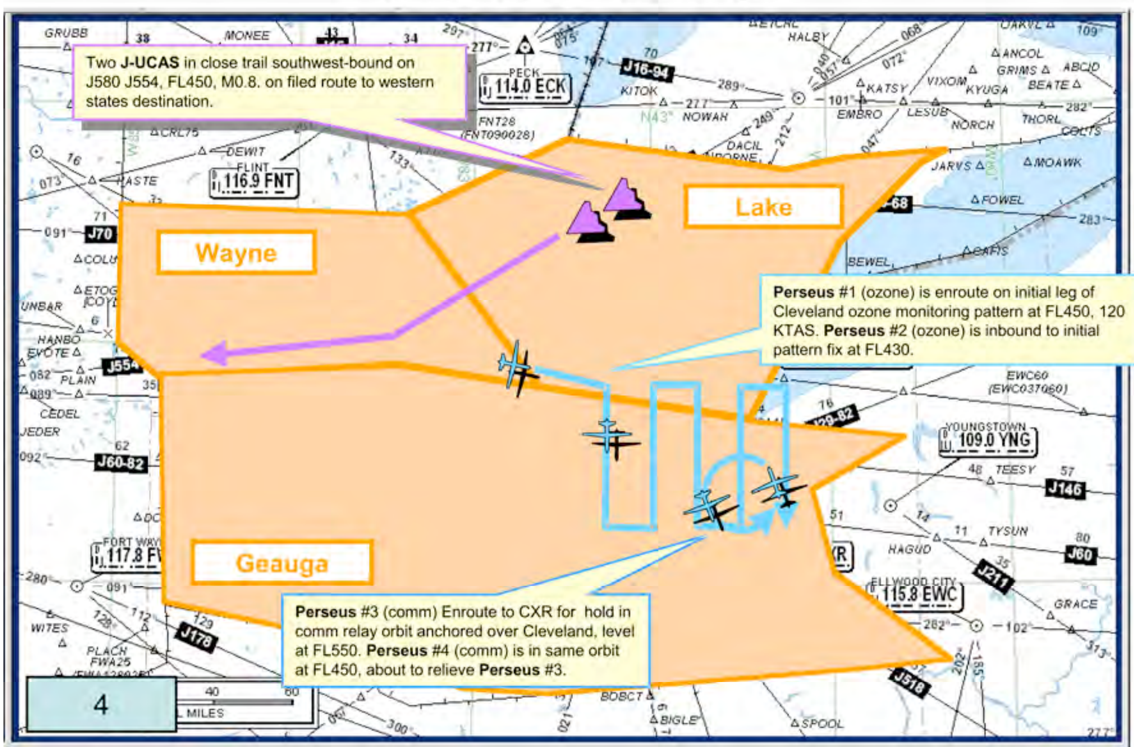
Scenario #2: Perseus Ozone Detroit + J-UCAS Eastbound Overflight



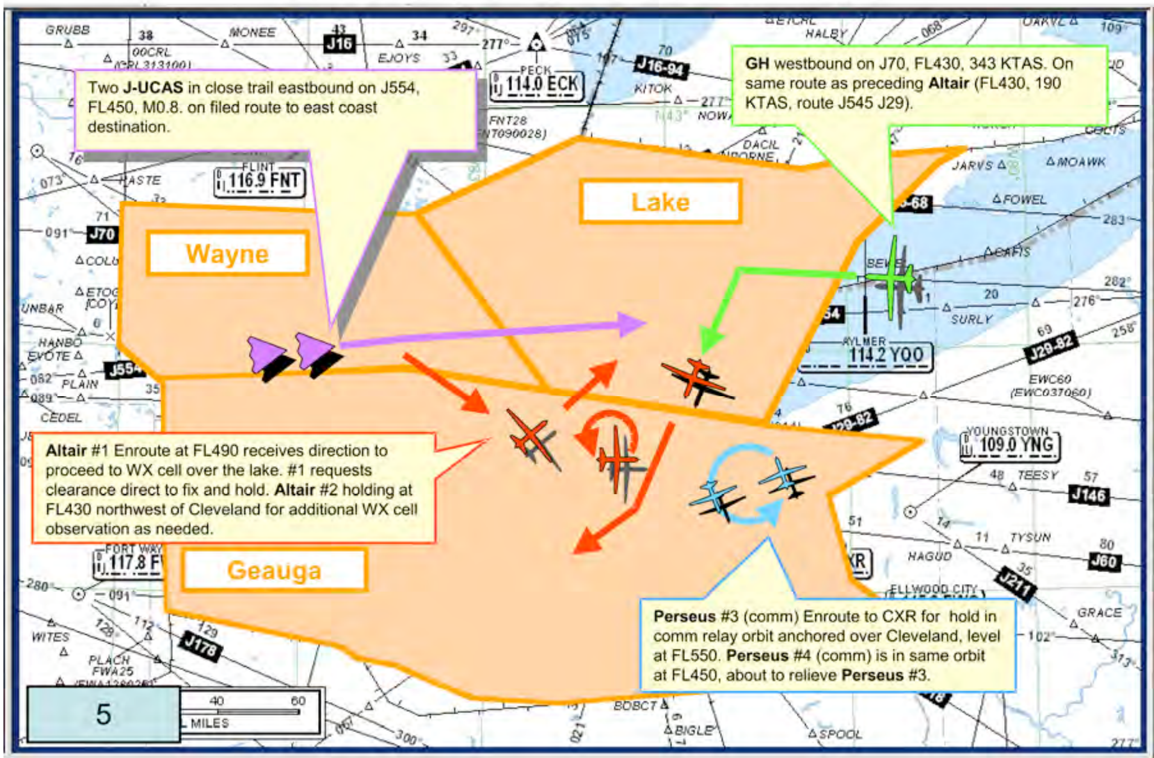
Scenario #3: Perseus Ozone Detroit +Altair WX + GH Homeland Security



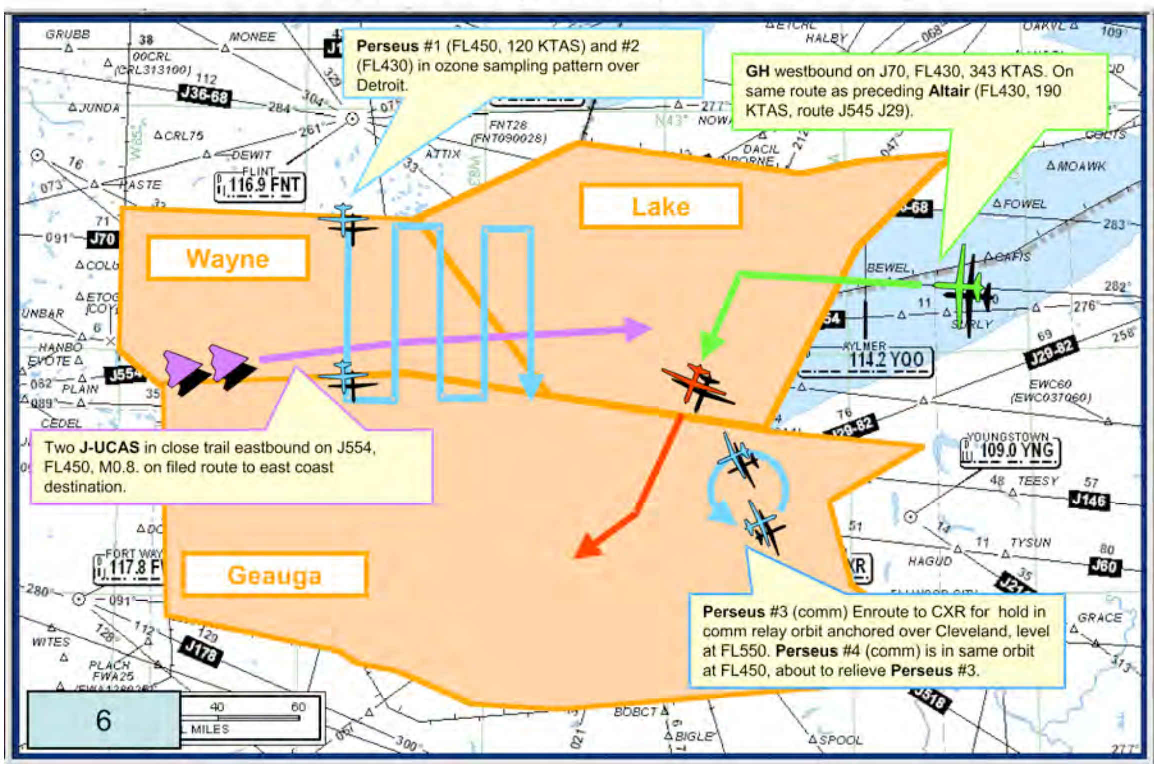
Scenario #4: Perseus Ozone Cleveland + Perseus Comm Relay Swap + Westbound J-UCAS Overflight



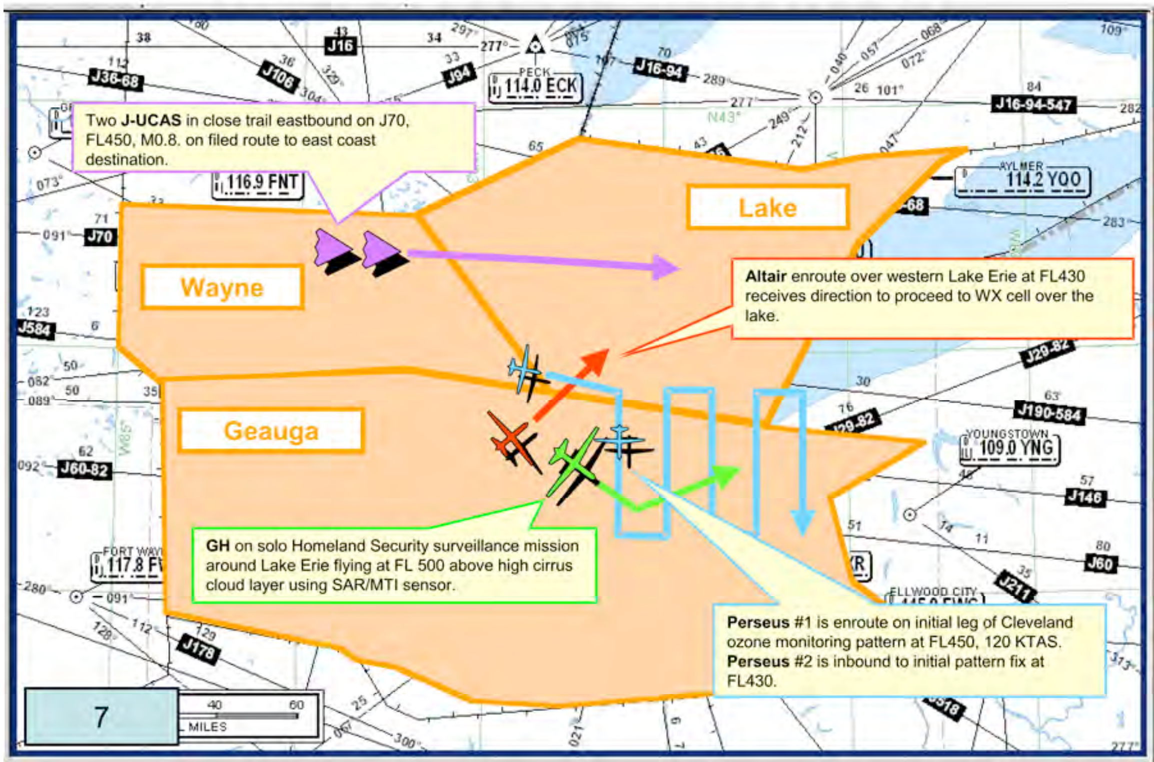
Scenario #5: Altair WX + Eastbound J-UCAS Overflight + Perseus Comm Relay Swap + GH/Altair Overflight



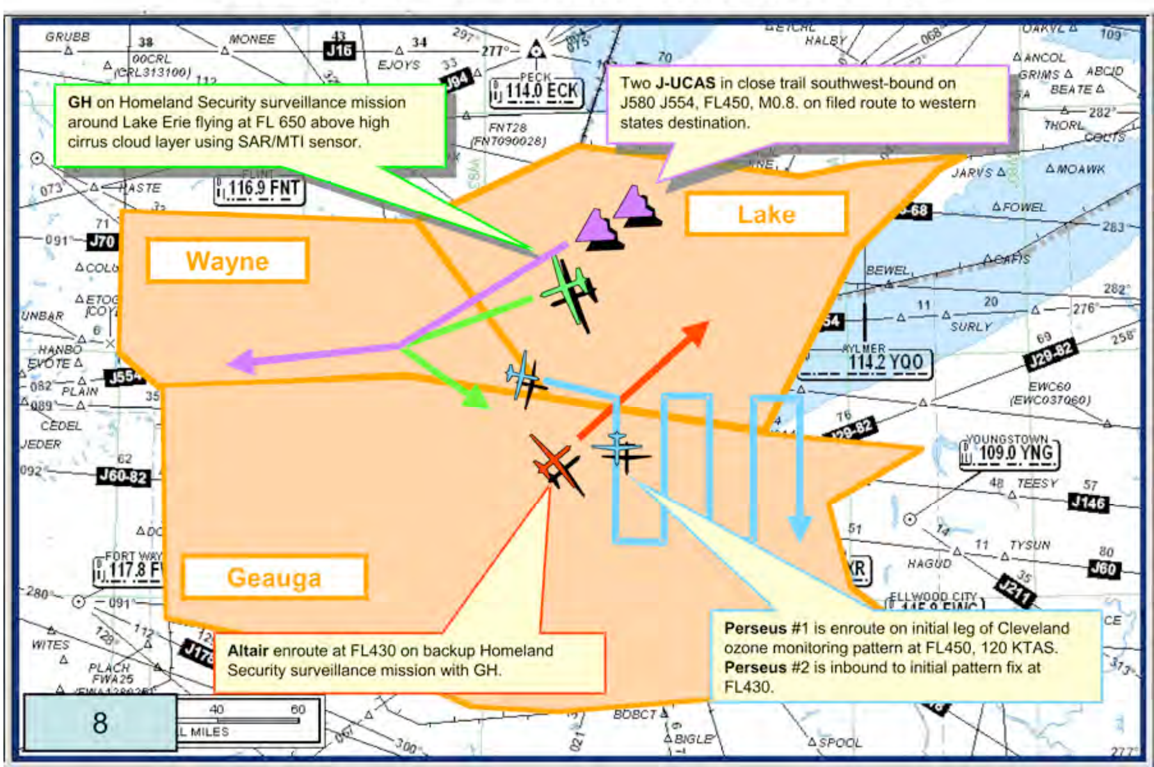
Scenario #6: J-UCAS Eastbound Overflight + Perseus Detroit Ozone + Perseus Comm Relay Swap + GH/Altair Overflight



Scenario #7: Global Hawk Solo Surveillance + Altair WX + Perseus Ozone Cleveland + J-UCAS Eastbound Overflight

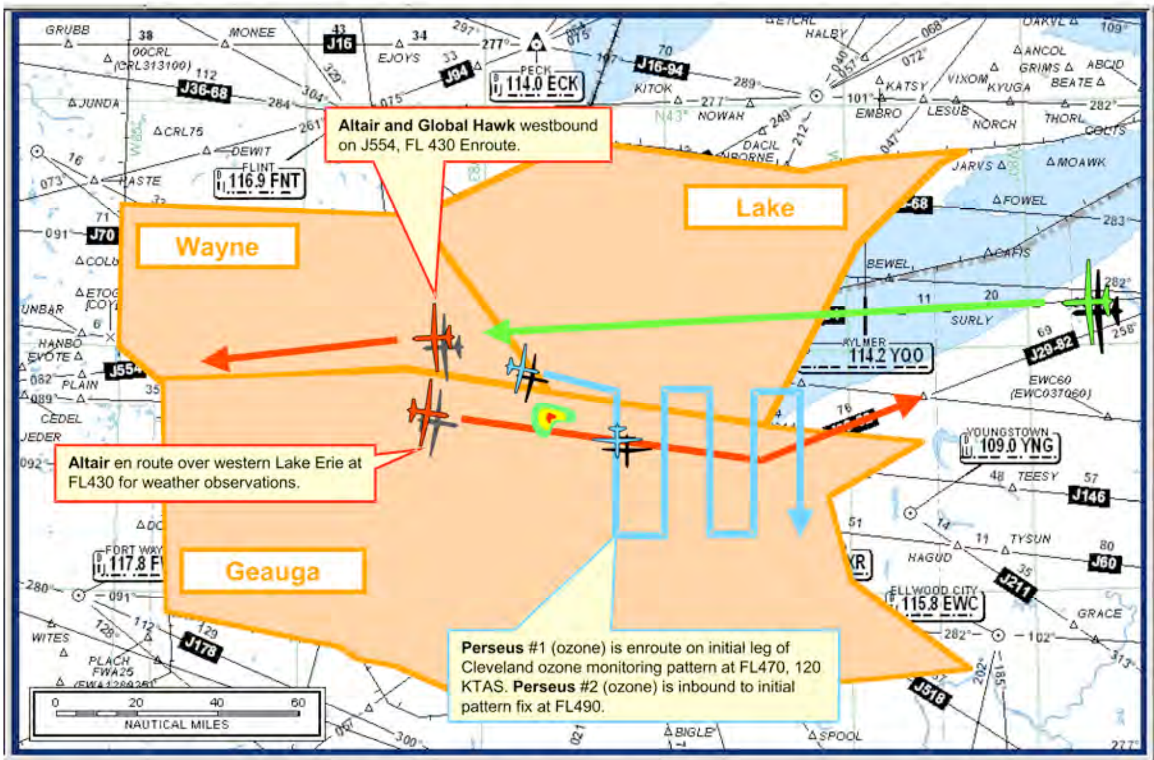


Scenario #8: Global Hawk & Altair Homeland Security + Perseus Ozone Cleveland +J-UCAS Westbound Overflight



Appendix E: Contingency Management AOS Controller Session Briefs

G (1): Altair WX + GH/Altair Enroute + Perseus Cleveland Ozone



ROA Contingency Management Procedures for Session G (1)

- **Pilot / ATC Voice Communication Reception Failure**
  - Pilot attempts to re-establish communication
  - If unable to re-establish reception, pilot commands ROA to squawk 7600
  - *Pilot contacts ATC by alternate means*
- **Lost UpLink / DownLink**
  - Pilot attempts to re-establish link
  - If unable to re-establish link, the ROA squawks 7700
- **Pilot / ATC Voice Communication Reception Failure and Lost UpLink / DownLink**
  - Pilot attempts to re-establish link
  - If unable to re-establish link, the ROA squawks 7700
  - Pilot attempts to report failure to ATC…fails
  - Pilot attempts to re-establish communication
  - *Pilot contacts ATC by alternate means*

Routing Procedure

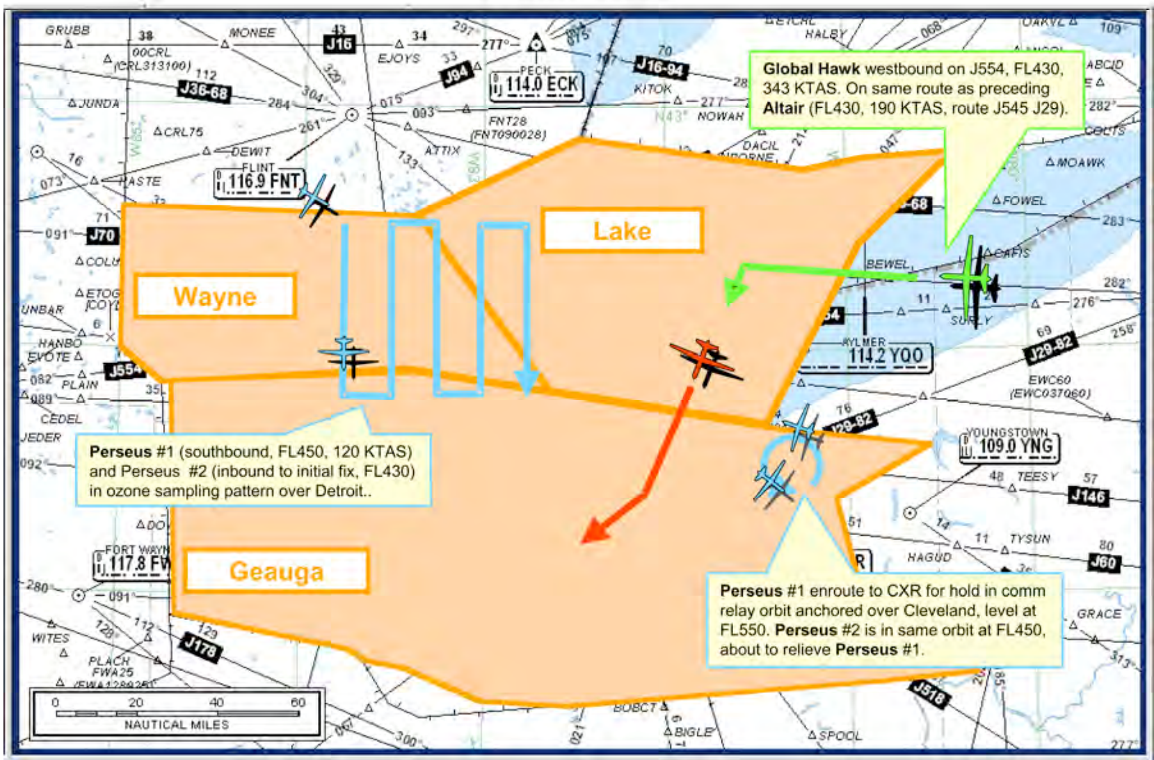
- For 2 minutes after detection, ROA remains on route and pilot attempts to re-establish failed system(s)
- If system(s) not re-established, ROA executes a standard turn to intercept closest waypoint on originally filed route
- At waypoint, ROA holds for 5 minutes to continue attempts to re-establish system function
- If system(s) still not re-established, ROA continues to destination airport via originally filed flight plan

ROA Contingency Management Procedures for Session G (1)

- **Unintended Altitude / Route Change**
  - Pilot attempts to re-establish appropriate ROA altitude / route
  - If unable to correct altitude / route, pilot commands ROA to Squawk 7700
  - Pilot reports altitude / route deviation to ATC

- **Performance Compromise / Failure**
  - Pilot attempts to re-establish nominal ROA performance
  - If unable to correct failure, pilot commands ROA to Squawk 7700
  - Pilot reports failure to ATC, and describes effects and intentions (route, sink rate, destination)
  - **Routing Procedure**
    - Pilot attempts to re-establish nominal ROA performance
    - If performance is <u>not</u> re-established, ROA is directed to execute best engine-out descent, given remaining ROA control authority, flight capability, etc
    - Descent path will follow shortest safe route to Nearest Suitable Airport

A (2): Perseus Ozone Detroit Overflight + GH/Altair +Perseus Comm Relay



ROA Contingency Management Procedures for Session A (2)

- **Pilot / ATC Voice Communication Reception Failure**
  - Pilot attempts to re-establish communication
  - If unable to re-establish reception, pilot commands ROA to squawk 7600
  - *Pilot contacts ATC by alternate means*
- **Lost UpLink / DownLink**
  - Pilot attempts to re-establish link
  - If unable to re-establish link, the ROA squawks 7700
- **Pilot / ATC Voice Communication Reception Failure <u>and</u> Lost UpLink / DownLink**
  - Pilot attempts to re-establish link
  - If unable to re-establish link, the ROA squawks 7700
  - Pilot attempts to report failure to ATC…fails
  - Pilot attempts to re-establish communication
  - *Pilot contacts ATC by alternate means*

<u>Routing Procedure</u>

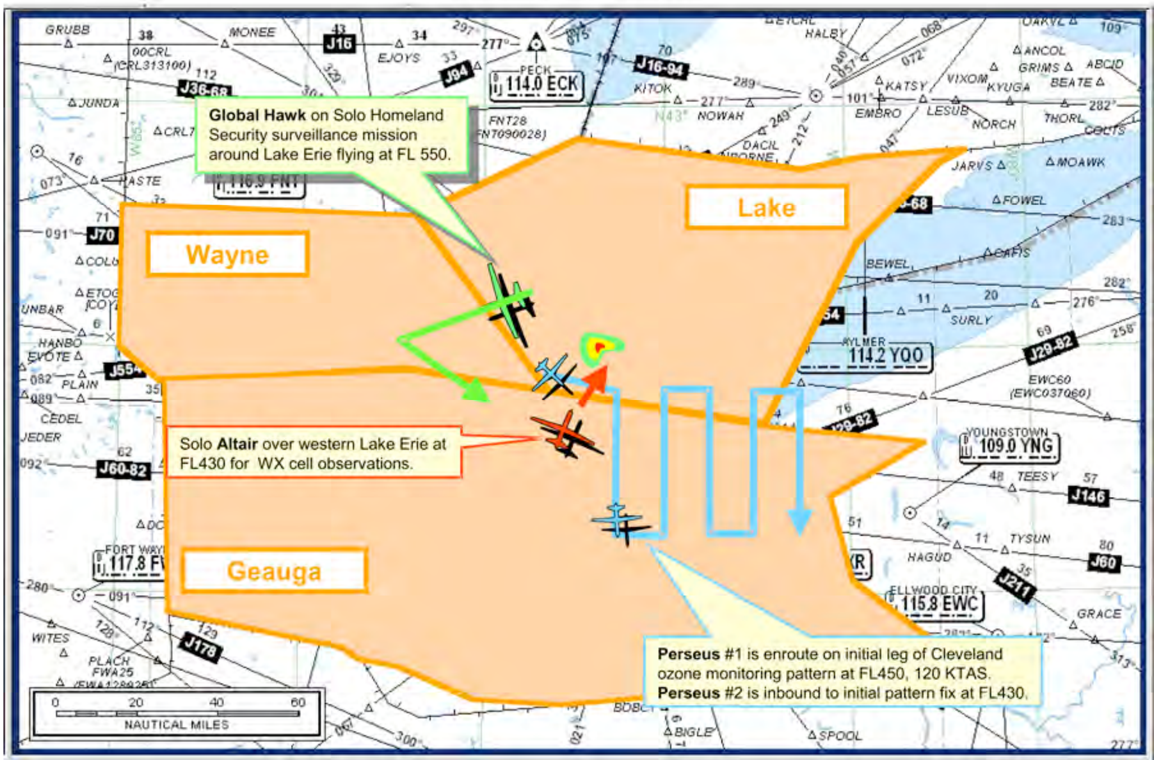
- For 5 minutes after detection, ROA remains on route and pilot attempts to re-establish failed system(s)
- If system(s) <u>not</u> re-established, ROA reverses current course via 30º teardrop
- ROA Returns to Base via reverse course of originally filed flight plan

ROA Contingency Management Procedures for Session A (2)

- **Unintended Altitude / Route Change**
  - Pilot attempts to re-establish appropriate ROA altitude / route
  - If unable to correct altitude / route, pilot commands ROA to Squawk 7700
  - Pilot reports altitude / route deviation to ATC

- **Performance Compromise / Failure**
  - Pilot attempts to re-establish nominal ROA performance
  - If unable to correct failure, pilot commands ROA to Squawk 7700
  - Pilot reports failure to ATC, and describes effects and intentions (route, sink rate, destination)
  - **Routing Procedure**
    - Pilot attempts to re-establish nominal ROA performance
    - If performance is not re-established, ROA is directed to execute best engine-out descent, given remaining ROA control authority, flight capability, etc
    - Descent path will follow shortest safe route to Nearest Suitable Airport

C (3): Solo Global Hawk Homeland Security + Altair Wx + Perseus Ozone Cleveland



ROA Contingency Management Procedures for Session C (3)

- **Pilot / ATC Voice Communication Reception Failure**
  - Pilot attempts to re-establish communication
  - If unable to re-establish reception, pilot commands ROA to squawk 7600
  - *Pilot contacts ATC by alternate means*
- **Lost UpLink / DownLink**
  - Pilot attempts to re-establish link
  - If unable to re-establish link, the ROA squawks 7700
- **Pilot / ATC Voice Communication Reception Failure and Lost UpLink / DownLink**
  - Pilot attempts to re-establish link
  - If unable to re-establish link, the ROA squawks 7700
  - Pilot attempts to report failure to ATC…fails
  - Pilot attempts to re-establish communication
  - *Pilot contacts ATC by alternate means*

Routing Procedure

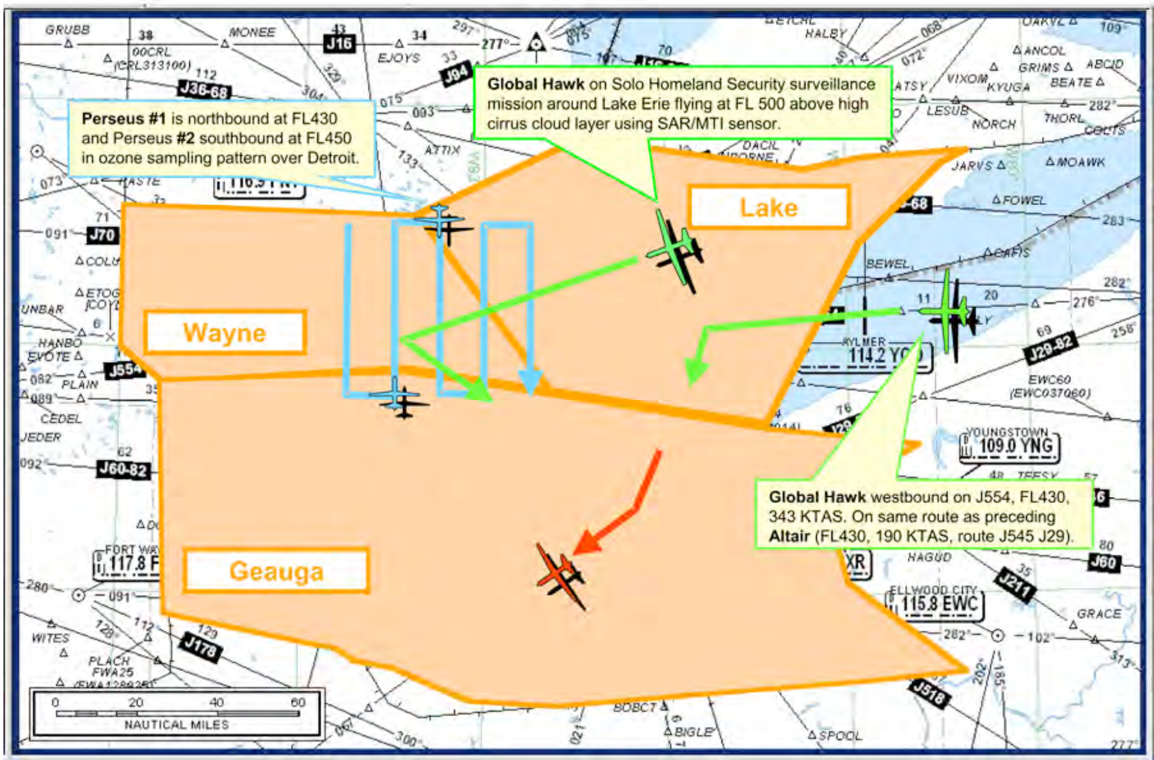
- For 2 minutes after detection, ROA remains on route and pilot attempts to re-establish failed system(s)
- If system(s) not re-established, ROA executes shortest safe off-airways descent route to Nearest Suitable Airport

ROA Contingency Management Procedures for Session C (3)

- **Unintended Altitude / Route Change**
  - Pilot attempts to re-establish appropriate ROA altitude / route
  - If unable to correct altitude / route, pilot commands ROA to Squawk 7700
  - Pilot reports altitude / route deviation to ATC

- **Performance Compromise / Failure**
  - Pilot attempts to re-establish nominal ROA performance
  - If unable to correct failure, pilot commands ROA to Squawk 7700
  - Pilot reports failure to ATC, and describes effects and intentions (route, sink rate, destination)
  - **Routing Procedure**
    - Pilot attempts to re-establish nominal ROA performance
    - If performance is <u>not</u> re-established, ROA is directed to execute best engine-out descent, given remaining ROA control authority, flight capability, etc
    - Descent path will follow shortest safe route to Nearest Suitable Airport

E (4): Perseus Ozone Detroit + GH/Altair + GH Solo Homeland Security



ROA Contingency Management Procedures for Session E (4)

- **Pilot / ATC Voice Communication Reception Failure**
  - Pilot attempts to re-establish communication
  - If unable to re-establish reception, pilot commands ROA to squawk 7600
  - *Pilot contacts ATC by alternate means*

Routing Procedure

- For **6 minutes** after detection, ROA remains on route and pilot attempts to re-establish failed system(s)
- If system(s) not re-established, ROA Returns to Base via shortest safe off-airways route

- **Lost UpLink / DownLink**
  - Pilot attempts to re-establish link
  - If unable to re-establish link, the ROA squawks 7700

- **Pilot / ATC Voice Communication Reception Failure and Lost UpLink / DownLink**
  - Pilot attempts to re-establish link
  - If unable to re-establish link, the ROA squawks 7700
  - Pilot attempts to report failure to ATC…fails
  - Pilot attempts to re-establish communication
  - *Pilot contacts ATC by alternate means*

Routing Procedure

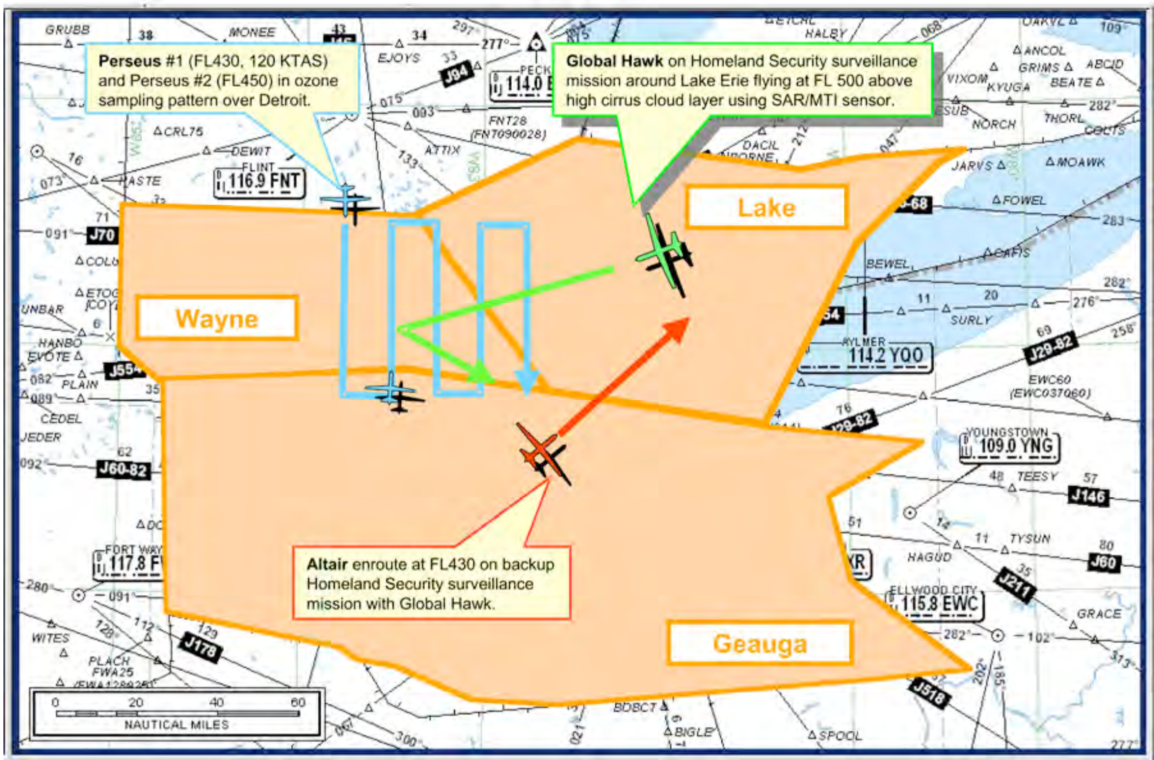
- For **3 minutes** after detection, ROA remains on route and pilot attempts to re-establish failed system(s)
- If system(s) not re-established, ROA Returns to Base via shortest safe off-airways route

ROA Contingency Management Procedures for Session E (4)

- **Unintended Altitude / Route Change**
  - Pilot attempts to re-establish appropriate ROA altitude / route
  - If unable to correct altitude / route, pilot commands ROA to Squawk 7700
  - Pilot reports altitude / route deviation to ATC

- **Performance Compromise / Failure**
  - Pilot attempts to re-establish nominal ROA performance
  - If unable to correct failure, pilot commands ROA to Squawk 7700
  - Pilot reports failure to ATC, and describes effects and intentions (route, sink rate, destination)
  - **Routing Procedure**
    - Pilot attempts to re-establish nominal ROA performance
    - If performance is <u>not</u> re-established, ROA is directed to execute best engine-out descent, given remaining ROA control authority, flight capability, etc
    - Descent path will follow shortest safe route to Nearest Suitable Airport

I (5): Global Hawk/Altair Homeland Security + Perseus Ozone Cleveland



ROA Contingency Management Procedures for Session I (5)

- **Pilot / ATC Voice Communication Reception Failure**
  - Pilot attempts to re-establish communication
  - If unable to re-establish reception, pilot commands ROA to squawk 7600
  - *Pilot contacts ATC by alternate means*
- **Lost UpLink / DownLink**
  - Pilot attempts to re-establish link
  - If unable to re-establish link, the ROA squawks 7700
- **Pilot / ATC Voice Communication Reception Failure <u>and</u> Lost UpLink / DownLink**
  - Pilot attempts to re-establish link
  - If unable to re-establish link, the ROA squawks 7700
  - Pilot attempts to report failure to ATC…fails
  - Pilot attempts to re-establish communication
  - *Pilot contacts ATC by alternate means*

<u>Routing Procedure</u>

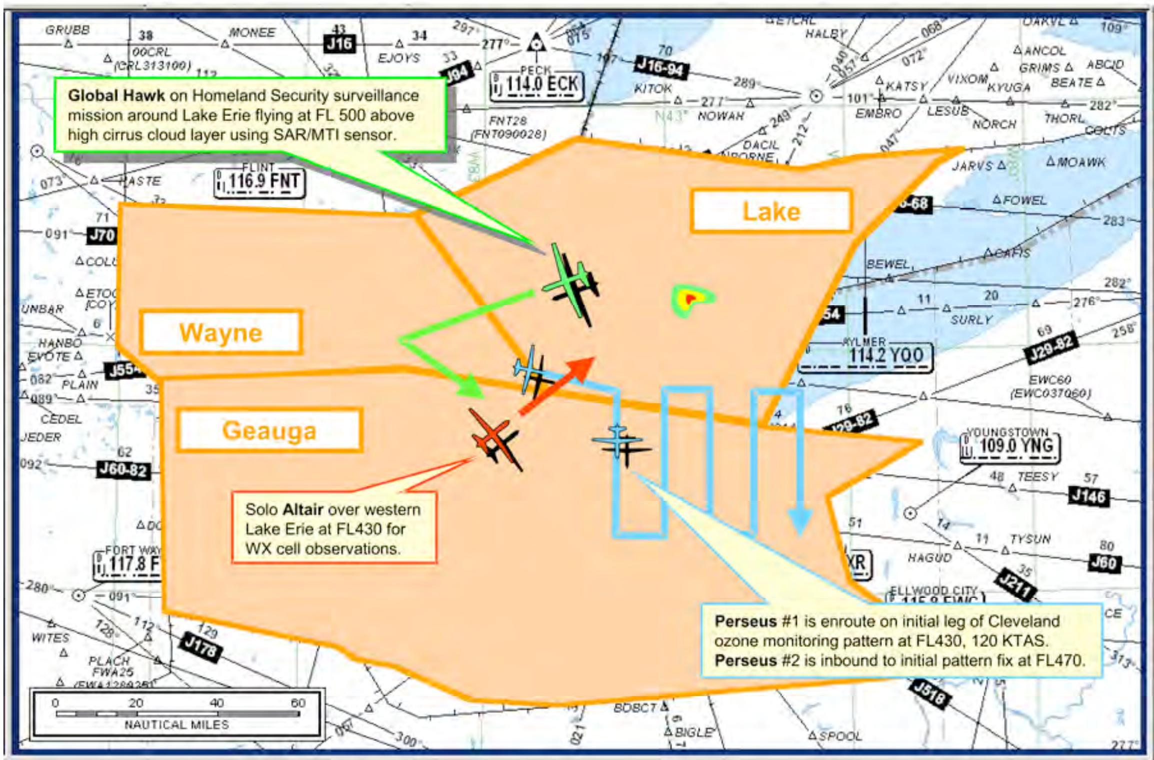
- For 3 minutes after detection, ROA remains on route and pilot attempts to re-establish failed system(s)
- If system(s) <u>not</u> re-established, ROA executes shortest safe off-airways descent route to Nearest Suitable Airport

ROA Contingency Management Procedures for Session I (5)

- **Unintended Altitude / Route Change**
  - Pilot attempts to re-establish appropriate ROA altitude / route
  - If unable to correct altitude / route, pilot commands ROA to Squawk 7700
  - Pilot reports altitude / route deviation to ATC

- **Performance Compromise / Failure**
  - Pilot attempts to re-establish nominal ROA performance
  - If unable to correct failure, pilot commands ROA to Squawk 7700
  - Pilot reports failure to ATC, and describes effects and intentions (route, sink rate, destination)
  - **Routing Procedure**
    - Pilot attempts to re-establish nominal ROA performance
    - If performance is <u>not</u> re-established, ROA is directed to execute best engine-out descent, given remaining ROA control authority, flight capability, etc
    - Descent path will follow shortest safe route to Nearest Suitable Airport

D (6): Global Hawk Solo + Altair WX + Perseus Cleveland Ozone



ROA Contingency Management Procedures for Session D (6)

- **Pilot / ATC Voice Communication Reception Failure**
  - Pilot attempts to re-establish communication
  - If unable to re-establish reception, pilot commands ROA to squawk 7600
  - *Pilot contacts ATC by alternate means*
- **Lost UpLink / DownLink**
  - Pilot attempts to re-establish link
  - If unable to re-establish link, the ROA squawks 7700
- **Pilot / ATC Voice Communication Reception Failure and Lost UpLink / DownLink**
  - Pilot attempts to re-establish link
  - If unable to re-establish link, the ROA squawks 7700
  - Pilot attempts to report failure to ATC…fails
  - Pilot attempts to re-establish communication
  - *Pilot contacts ATC by alternate means*

Routing Procedure

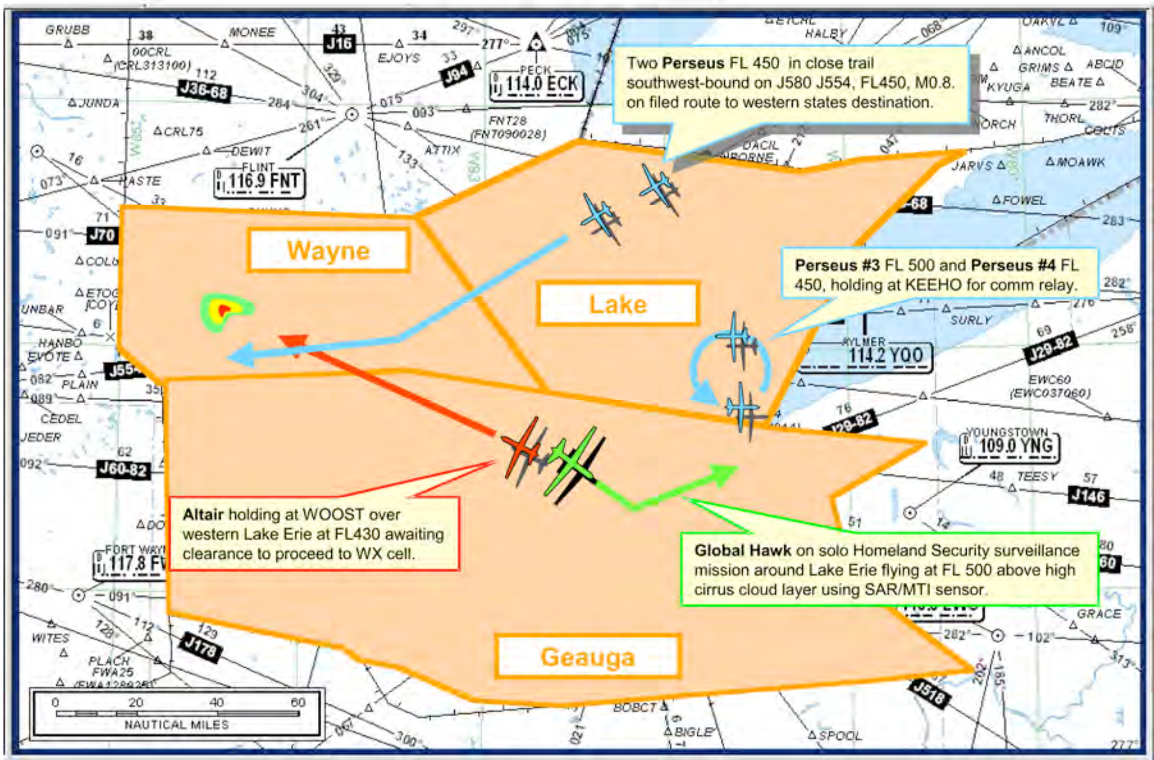
- For 6 minutes after detection, ROA remains on route and pilot attempts to re-establish failed system(s)
- If system(s) not re-established, ROA continues to destination airport via originally filed flight plan

ROA Contingency Management Procedures for Session D (6)

- **Unintended Altitude / Route Change**
  - Pilot attempts to re-establish appropriate ROA altitude / route
  - If unable to correct altitude / route, pilot commands ROA to Squawk 7700
  - Pilot reports altitude / route deviation to ATC

- **Performance Compromise / Failure**
  - Pilot attempts to re-establish nominal ROA performance
  - If unable to correct failure, pilot commands ROA to Squawk 7700
  - Pilot reports failure to ATC, and describes effects and intentions (route, sink rate, destination)
  - **Routing Procedure**
    - Pilot attempts to re-establish nominal ROA performance
    - If performance is <u>not</u> re-established, ROA is directed to execute best engine-out descent, given remaining ROA control authority, flight capability, etc
    - Descent path will follow shortest safe route to Nearest Suitable Airport

F (7): Altair WX + Perseus Comm Relay Swap + Global Hawk Solo Homeland Security



ROA Contingency Management Procedures for Session F (7)

- **Pilot / ATC Voice Communication Reception Failure**
  - Pilot attempts to re-establish communication
  - If unable to re-establish reception, pilot commands ROA to squawk 7600
  - *Pilot contacts ATC by alternate means*
- **Lost UpLink / DownLink**
  - Pilot attempts to re-establish link
  - If unable to re-establish link, the ROA squawks 7700
- **Pilot / ATC Voice Communication Reception Failure <u>and</u> Lost UpLink / DownLink**
  - Pilot attempts to re-establish link
  - If unable to re-establish link, the ROA squawks 7700
  - Pilot attempts to report failure to ATC…fails
  - Pilot attempts to re-establish communication
  - *Pilot contacts ATC by alternate means*

<u>Routing Procedure</u>

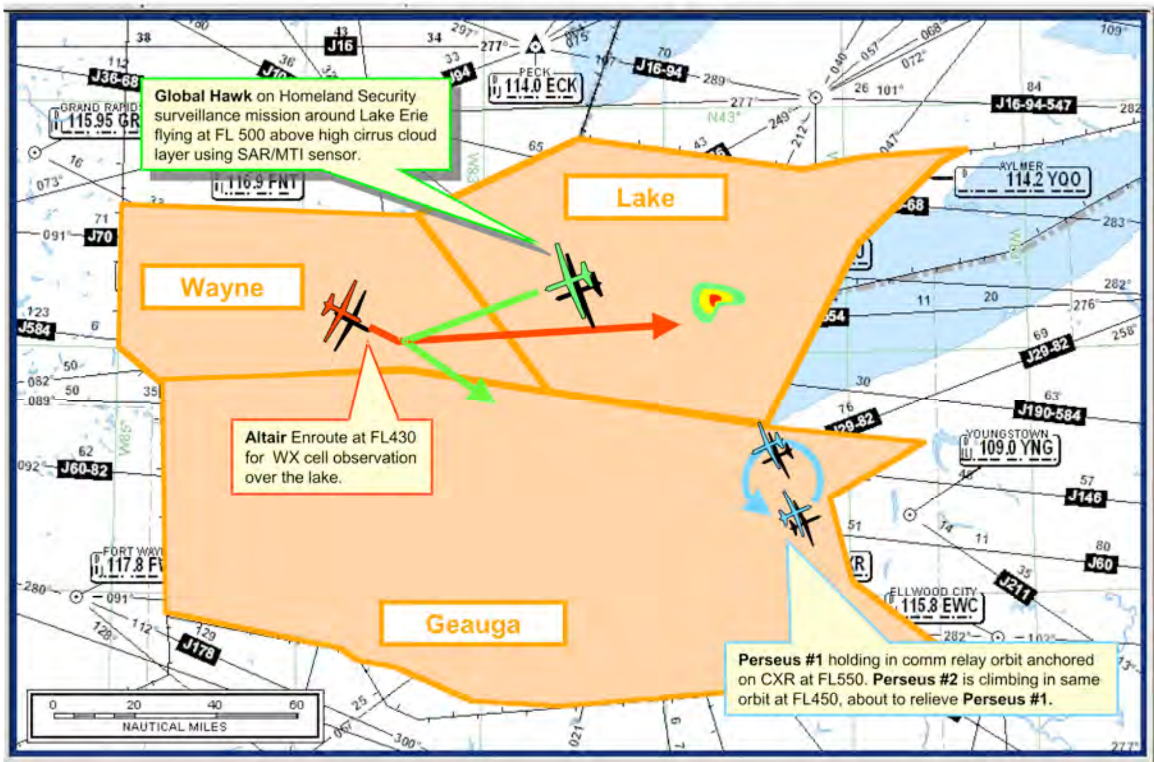
- For 8 minutes after detection, ROA remains on route and pilot attempts to re-establish failed system(s)
- If system(s) <u>not</u> re-established, ROA holds for 6 minutes at approaching waypoint to continue attempts to re-establish system function
- If system(s) still <u>not</u> re-established, ROA executes shortest safe descent route to Nearest Suitable Airport

ROA Contingency Management Procedures for Session F (7)

- **Unintended Altitude / Route Change**
  - Pilot attempts to re-establish appropriate ROA altitude / route
  - If unable to correct altitude / route, pilot commands ROA to Squawk 7700
  - Pilot reports altitude / route deviation to ATC

- **Performance Compromise / Failure**
  - Pilot attempts to re-establish nominal ROA performance
  - If unable to correct failure, pilot commands ROA to Squawk 7700
  - Pilot reports failure to ATC, and describes effects and intentions (route, sink rate, destination)
  - **Routing Procedure**
    - Pilot attempts to re-establish nominal ROA performance
    - If performance is <u>not</u> re-established, ROA is directed to execute best engine-out descent, given remaining ROA control authority, flight capability, etc
    - Descent path will follow shortest safe route to Nearest Suitable Airport

B (8): Altair WX + Perseus Comm Relay Swap + Global Hawk Solo Homeland Security



ROA Contingency Management Procedures for Session B (8)

- **Pilot / ATC Voice Communication Reception Failure**
  - Pilot attempts to re-establish communication
  - If unable to re-establish reception, pilot commands ROA to squawk 7600
  - *Pilot contacts ATC by alternate means*

- **Lost UpLink / DownLink**
  - Pilot attempts to re-establish link
  - If unable to re-establish link, the ROA squawks 7700

- **Pilot / ATC Voice Communication Reception Failure <u>and</u> Lost UpLink / DownLink**
  - Pilot attempts to re-establish link
  - If unable to re-establish link, the ROA squawks 7700
  - Pilot attempts to report failure to ATC…fails
  - Pilot attempts to re-establish communication
  - *Pilot contacts ATC by alternate means*

<u>Routing Procedure</u>

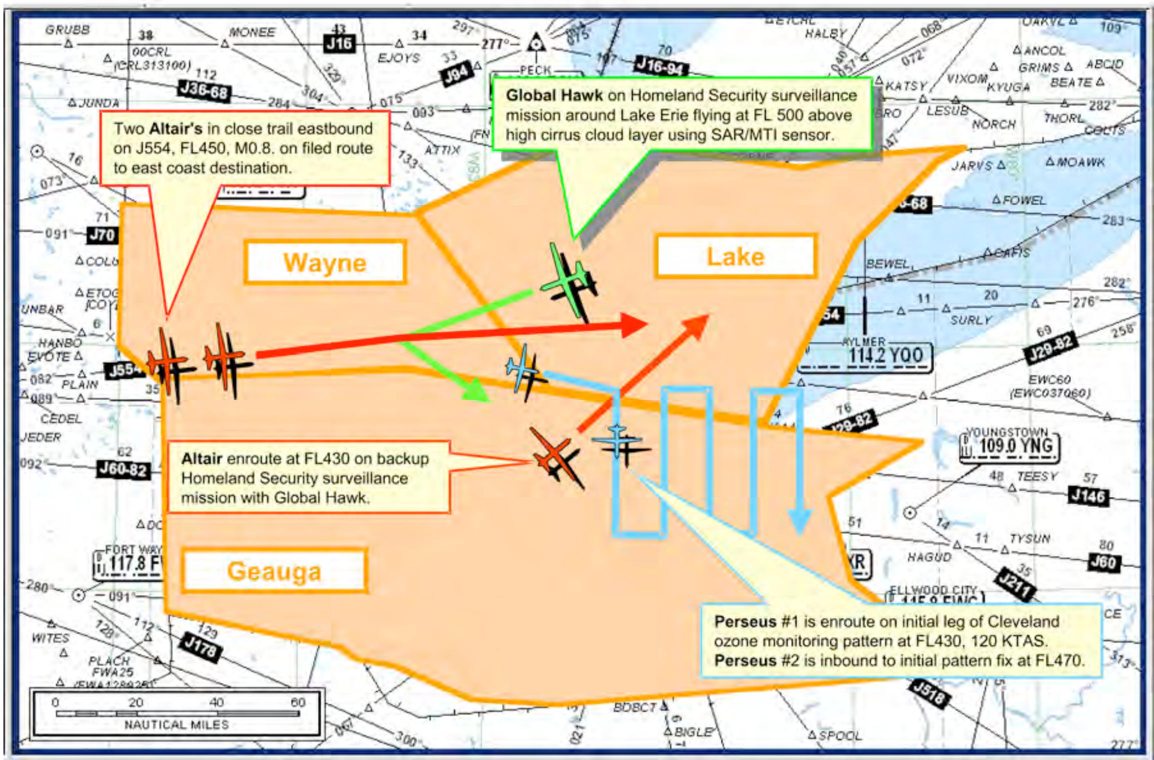
- For 5 minutes after detection, ROA remains on route and pilot attempts to re-establish failed system(s)
- If system(s) <u>not</u> re-established, ROA reverses current course via 30º teardrop
- ROA Returns to Base via reverse course of originally filed flight plan

ROA Contingency Management Procedures for Session B (8)

- **Unintended Altitude / Route Change**
  - Pilot attempts to re-establish appropriate ROA altitude / route
  - If unable to correct altitude / route, pilot commands ROA to Squawk 7700
  - Pilot reports altitude / route deviation to ATC

- **Performance Compromise / Failure**
  - Pilot attempts to re-establish nominal ROA performance
  - If unable to correct failure, pilot commands ROA to Squawk 7700
  - Pilot reports failure to ATC, and describes effects and intentions (route, sink rate, destination)
  - **Routing Procedure**
    - Pilot attempts to re-establish nominal ROA performance
    - If performance is <u>not</u> re-established, ROA is directed to execute best engine-out descent, given remaining ROA control authority, flight capability, etc
    - Descent path will follow shortest safe route to Nearest Suitable Airport

H (9): Global Hawk/Altair Homeland Security + Perseus Ozone Cleveland



ROA Contingency Management Procedures for Session H (9)

- **Pilot / ATC Voice Communication Reception Failure**
  - Pilot attempts to re-establish communication
  - If unable to re-establish reception, pilot commands ROA to squawk 7600
  - *Pilot contacts ATC by alternate means*
- **Lost UpLink / DownLink**
  - Pilot attempts to re-establish link
  - If unable to re-establish link, the ROA squawks 7700
- **Pilot / ATC Voice Communication Reception Failure and Lost UpLink / DownLink**
  - Pilot attempts to re-establish link
  - If unable to re-establish link, the ROA squawks 7700
  - Pilot attempts to report failure to ATC…fails
  - Pilot attempts to re-establish communication
  - *Pilot contacts ATC by alternate means*

Routing Procedure

- For 2 minutes after detection, ROA remains on route and pilot attempts to re-establish failed system(s)
- If system(s) not re-established, ROA executes shortest safe off-airways descent route to Nearest Suitable Airport

ROA Contingency Management Procedures for Session H (9)

- **Unintended Altitude / Route Change**
  - Pilot attempts to re-establish appropriate ROA altitude / route
  - If unable to correct altitude / route, pilot commands ROA to Squawk 7700
  - Pilot reports altitude / route deviation to ATC

- **Performance Compromise / Failure**
  - Pilot attempts to re-establish nominal ROA performance
  - If unable to correct failure, pilot commands ROA to Squawk 7700
  - Pilot reports failure to ATC, and describes effects and intentions (route, sink rate, destination)
  - **Routing Procedure**
    - Pilot attempts to re-establish nominal ROA performance
    - If performance is <u>not</u> re-established, ROA is directed to execute best engine-out descent, given remaining ROA control authority, flight capability, etc
    - Descent path will follow shortest safe route to Nearest Suitable Airport

Appendix F: Normal AOS Controller Questionnaires

Participant Controller Post Run Questionnaire – Access 5

Date/Time: 07.14.2005/2:30PM PST Scenario #:1

Please rate the traffic load. Consider aircraft volume, route complexity, impact of UAVs, and any other factors you believe relevant.

	1	2	3	4	5	6	7
	Very Low	Low	Somewhat Low	Average	Somewhat High	High	Very High
26 – Lake				x			
29 - Wayne				x			
45 - Geauga					x		

To what degree did the presence of UAVs in the scenario affect the complexity of performing primary controller duties.

	1	2	3	4	5	6	7
	Decreased Complexity	<<<	<<<	No Effect	>>>	>>>	Increased Complexity
26 – Lake					x		
29 – Wayne				x			
45 - Geauga						x	

Was there any one UAV-related event in the scenario that was of note? If so, briefly describe the circumstances and any action you may have taken. Examples of an "event" include a loss of communications with a UAV, a UAV-UAV conflict, a UAV-piloted aircraft conflict, etc.

26 – Lake	G.H. faster behind Altair @ F430, I climbed the Altair to FL450. 2-Perseus holding 20ish miles apart @ FL430. I had to monitor frequently to ensure they didn't stray out of their holding patterns.
29 – Wayne	-
45 - Geauga	I had 5 missions going with moderate en-route traffic. 3 of the missions were at FL430 which required additional attention.

What, if anything, was the most complex, difficult, or challenging element in having UAVs present in the scenario just completed? Briefly describe, please.

26 – Lake	Monitoring the holding Perseus'
29 – Wayne	-
45 - Geauga	Keeping track of 5 missions with moderate en-route traffic was the challenge. Extra attention was given to 3 missions at FL430.

Did any UAV-related activity or event impact operational safety in the scenario just completed? If so, please describe the circumstances and context, as well as any action you may have taken.

26 – Lake	no
29 – Wayne	-
45 - Geauga	No safety problems.

Is there a procedural, operational, or phraseology change that might have proved useful in dealing with any UAV-related challenge experienced in the scenario just completed?

26 – Lake	no
29 – Wayne	-
45 - Geauga	no

Any other comments or observations related to the scenario just completed?

26 – Lake	
29 – Wayne	-
45 - Geauga	no

Participant Controller Post Run Questionnaire – Access 5

Date/Time: 7.14.2005/10AM PST Scenario #: 2

Please rate the traffic load. Consider aircraft volume, route complexity, impact of UAVs, and any other factors you believe relevant.

	1	2	3	4	5	6	7
	Very Low	Low	Somewhat Low	Average	Somewhat High	High	Very High
26 – Lake					x		
29 - Wayne					x		
45 - Geauga				x			

To what degree did the presence of UAVs in the scenario affect the complexity of performing primary controller duties.

	1	2	3	4	5	6	7
	Decreased Complexity	<<<	<<<	No Effect	>>>	>>>	Inccreased Complexity
26 – Lake					x		
29 – Wayne					x		
45 - Geauga				x			

Was there any one UAV-related event in the scenario that was of note? If so, briefly describe the circumstances and any action you may have taken. Examples of an "event" include a loss of communications with a UAV, a UAV-UAV conflict, a UAV-piloted aircraft conflict, etc.

26 – Lake	no
29 – Wayne	No "events"
45 - Geauga	No problems

What, if anything, was the most complex, difficult, or challenging element in having UAVs present in the scenario just completed? Briefly describe, please.

26 – Lake	It was just another couple of data block in the immediate vicinity of several aircraft at lower altitudes. So, keeping the data blocks apart so I could read them increased the work load a little.
29 – Wayne	Very little impact from UAVs – No conflicting traffic this problem. Very small increase in workload just to maintain awareness of their presence and possible confliction in the future.
45 - Geauga	No problems, light traffic.

Did any UAV-related activity or event impact operational safety in the scenario just completed? If so, please describe the circumstances and context, as well as any action you may have taken.

26 – Lake	no
29 – Wayne	-no-
45 - Geauga	No problems, light traffic.

Is there a procedural, operational, or phraseology change that might have proved useful in dealing with any UAV-related challenge experienced in the scenario just completed?

26 – Lake	no
29 – Wayne	-no-
45 - Geauga	no

Any other comments or observations related to the scenario just completed?

26 – Lake	
29 – Wayne	-
45 - Geauga	no

Participant Controller Post Run Questionnaire – Access 5

Date/Time: 07.13.2005/130PM PST Scenario #: 3

Please rate the traffic load. Consider aircraft volume, route complexity, impact of UAVs, and any other factors you believe relevant.

	1	2	3	4	5	6	7
	Very Low	Low	Somewhat Low	Average	Somewhat High	High	Very High
26 – Lake				x			
29 - Wayne				x			
45 - Geauga				x			

To what degree did the presence of UAVs in the scenario affect the complexity of performing primary controller duties.

	1	2	3	4	5	6	7
	Decreased Complexity	<<<	<<<	No Effect	>>>	>>>	Inccreased Complexity
26 – Lake					x		
29 – Wayne					x		
45 - Geauga				x			

Was there any one UAV-related event in the scenario that was of note? If so, briefly describe the circumstances and any action you may have taken. Examples of an "event" include a loss of communications with a UAV, a UAV-UAV conflict, a UAV-piloted aircraft conflict, etc.

26 – Lake	GH diverted to hold over DOGGS intersection @ FL430. this resulted in climbing a couple of gen. aviation aircraft to FL450 to resolve the conflicts. It also resulted in several traffic advisory calls
29 – Wayne	UAV-acft conflict. Altitude change on acft solved situation.
45 - Geauga	Traffic was light, UAV traffic no factor.

What, if anything, was the most complex, difficult, or challenging element in having UAVs present in the scenario just completed? Briefly describe, please.

26 – Lake	Just a little increase in workload
29 – Wayne	-
45 - Geauga	No problems, light traffic.

Did any UAV-related activity or event impact operational safety in the scenario just completed? If so, please describe the circumstances and context, as well as any action you may have taken.

26 – Lake	no
29 – Wayne	no
45 - Geauga	No impact

Is there a procedural, operational, or phraseology change that might have proved useful in dealing with any UAV-related challenge experienced in the scenario just completed?

26 – Lake	I probably wouldn't have known the intentions of GH in area 2 based on the pre-briefing because he wasn't originally projected to fly through my airspace, (it was preplanned to be in the Geauga sector only.)
29 – Wayne	-
45 - Geauga	no

Any other comments or observations related to the scenario just completed?

26 – Lake	
29 – Wayne	-
45 - Geauga	no

Participant Controller Post Run Questionnaire – Access 5

Date/Time: 07.13.2005/0930AM PST Scenario #: 4

Please rate the traffic load. Consider aircraft volume, route complexity, impact of UAVs, and any other factors you believe relevant.

	1	2	3	4	5	6	7
	Very Low	Low	Somewhat Low	Average	Somewhat High	High	Very High
26 – Lake					x		
29 - Wayne				x			
45 - Geauga					x		

To what degree did the presence of UAVs in the scenario affect the complexity of performing primary controller duties.

	1	2	3	4	5	6	7
	Decreased Complexity	<<<	<<<	No Effect	>>>	>>>	Inccreased Complexity
26 – Lake					x		
29 – Wayne				x			
45 - Geauga						x	

Was there any one UAV-related event in the scenario that was of note? If so, briefly describe the circumstances and any action you may have taken. Examples of an "event" include a loss of communications with a UAV, a UAV-UAV conflict, a UAV-piloted aircraft conflict, etc.

26 – Lake	BLNG3 checked on my frequency when I didn't have track control. I had to find out where he was and put him on the correct frequency (which was 120.32).
29 – Wayne	Lost comm. w/ BLNG3. Raised workload somewhat.
45 - Geauga	Perseus 3 & 4 requested to hold at CXR, but continued north into ZOB 26 airspace. Lead J-UCAS aircraft had problems going direct to DJB, we also did not talk to aircraft in timely manner.

What, if anything, was the most complex, difficult, or challenging element in having UAVs present in the scenario just completed? Briefly describe, please.

26 – Lake	There was a very minimal impact of having to keep the data block displayed for Perseus 1 & 2 as I took a blanket point out from Geauga after I had worked them.
29 – Wayne	none
45 - Geauga	Main problem was aircraft cleared to hold at CXR did not hold there. Increased coordination with ZOB-26 sector.

Did any UAV-related activity or event impact operational safety in the scenario just completed? If so, please describe the circumstances and context, as well as any action you may have taken.

26 – Lake	no
29 – Wayne	No impact on safety.
45 - Geauga	No safety issues in ZOB-45 airspace

Is there a procedural, operational, or phraseology change that might have proved useful in dealing with any UAV-related challenge experienced in the scenario just completed?

26 – Lake	no
29 – Wayne	none
45 - Geauga	Need to know what direction, length of legs of holding pattern airspace. This will help expedite coordination with adjacent sectors.

Any other comments or observations related to the scenario just completed?

26 – Lake	
29 – Wayne	Relatively routine operation with little if any impact related to UAVs.
45 - Geauga	Slow moving aircraft data tags cause extra work keeping overall data tags from overlapping.

Participant Controller Post Run Questionnaire – Access 5

Date/Time:07.14.2005/4PM PST Scenario #: 5

Please rate the traffic load. Consider aircraft volume, route complexity, impact of UAVs, and any other factors you believe relevant.

	1	2	3	4	5	6	7
	Very Low	Low	Somewhat Low	Average	Somewhat High	High	Very High
26 – Lake						x	
29 - Wayne			x				
45 - Geauga							x

To what degree did the presence of UAVs in the scenario affect the complexity of performing primary controller duties.

	1	2	3	4	5	6	7
	Decreased Complexity	<<<	<<<	No Effect	>>>	>>>	Inccreased Complexity
26 – Lake					x		
29 – Wayne				x			
45 - Geauga							x

Was there any one UAV-related event in the scenario that was of note? If so, briefly describe the circumstances and any action you may have taken. Examples of an "event" include a loss of communications with a UAV, a UAV-UAV conflict, a UAV-piloted aircraft conflict, etc.

26 – Lake	I can't remember specifics.
29 – Wayne	UAV change of destination – no impact.
45 - Geauga	UAV traffic no problem, but with very high traffic volume in this sector, 3 people would have been assigned to this position in the real world.

What, if anything, was the most complex, difficult, or challenging element in having UAVs present in the scenario just completed? Briefly describe, please.

26 – Lake	
29 – Wayne	-
45 - Geauga	The presence of UAVs with high traffic was very difficult. Monitoring UAVs in holding also added complexity.

Did any UAV-related activity or event impact operational safety in the scenario just completed? If so, please describe the circumstances and context, as well as any action you may have taken.

26 – Lake	
29 – Wayne	no
45 - Geauga	No safety problems, just sector workload.

Is there a procedural, operational, or phraseology change that might have proved useful in dealing with any UAV-related challenge experienced in the scenario just completed?

26 – Lake	
29 – Wayne	no
45 - Geauga	no

Any other comments or observations related to the scenario just completed?

26 – Lake	The limiting factor involved having aircraft in your sector nordo. The UAVs increased the workload inly a small amount compared to the nordo aircraft and not being able to initiate control actions outside of your sector. Remote controller (communications wise) is needed to work this volume of traffic.
29 – Wayne	Several route issues were documented.
45 - Geauga	Very high volume, very complex situations, fast & slow UAVs made this extremely difficult.

Participant Controller Post Run Questionnaire – Access 5

Date/Time: 07.14.2005/1130AM PST Scenario #: 6

Please rate the traffic load. Consider aircraft volume, route complexity, impact of UAVs, and any other factors you believe relevant.

	1	2	3	4	5	6	7
	Very Low	Low	Somewhat Low	Average	Somewhat High	High	Very High
26 – Lake						x	
29 - Wayne						x	
45 - Geauga							x

To what degree did the presence of UAVs in the scenario affect the complexity of performing primary controller duties.

	1	2	3	4	5	6	7
	Decreased Complexity	<<<	<<<	No Effect	>>>	>>>	Inccreased Complexity
26 – Lake					x		
29 – Wayne						x	
45 - Geauga							x

Was there any one UAV-related event in the scenario that was of note? If so, briefly describe the circumstances and any action you may have taken. Examples of an "event" include a loss of communications with a UAV, a UAV-UAV conflict, a UAV-piloted aircraft conflict, etc.

26 – Lake	Overtake situation at F430 between an Altair and a Perseus. I climbed the Perseus to FL450. It would have been nice to know ahead of time which mission has priority.
29 – Wayne	UAV conflict with piloted acft. Vectored PA south to make sure separation was maintained.
45 - Geauga	Overall sector traffic was very high and complex, UAV-related traffic took this one step higher. Normal world this sector would have been staffed with 3 people (radar, radar associate, tracker).

What, if anything, was the most complex, difficult, or challenging element in having UAVs present in the scenario just completed? Briefly describe, please.

26 – Lake	Before making a decision on how to resolve the preceding situation, I would like to be able to quick-look the other sector(s) that it would affect to make a more informed decision on who to move.
29 – Wayne	Normal scan was made complex to adjust for slow speed of perseus. I seemed to have to rethink the presence of the UAV and conflicting traffic numerous times.
45 - Geauga	Just their presence in the sector, moving slow increased complexity. Then additional UAV traffic requesting to come into this sector would have been denied due to vol.

Did any UAV-related activity or event impact operational safety in the scenario just completed? If so, please describe the circumstances and context, as well as any action you may have taken.

26 – Lake	no
29 – Wayne	No impact on safety. Normal traffic vectors solved the situation.
45 - Geauga	Safety not an issue due to altitudes. UAVs at any lower altitudes would have been a different story.

Is there a procedural, operational, or phraseology change that might have proved useful in dealing with any UAV-related challenge experienced in the scenario just completed?

26 – Lake	no
29 – Wayne	no
45 - Geauga	We, as an area (sector team) would have to be more proactive with en-route traffic so as to not allow saturation of sector and still provide service to UAVs

Any other comments or observations related to the scenario just completed?

26 – Lake	In the middle of the session there were a couple of aircraft that checked on my frequency that I had to go look for. They were 30 or 40 miles outside of my airspace. It showed that I had track control even though I hadn't taken the hand off.
29 – Wayne	Complexity would have increased had the grid pattern extended into Geauga airspace.
45 - Geauga	Real world traffic, even with 3 people working sector, volume was extreme. We as an area (Sector team) would have moved traffic around this sector.

Participant Controller Post Run Questionnaire – Access 5

Date/Time: 07.13.2005/3PM PST Scenario #: 7

Please rate the traffic load. Consider aircraft volume, route complexity, impact of UAVs, and any other factors you believe relevant.

	1	2	3	4	5	6	7
	Very Low	Low	Somewhat Low	Average	Somewhat High	High	Very High
26 – Lake					x		
29 - Wayne				x			
45 - Geauga						x	

To what degree did the presence of UAVs in the scenario affect the complexity of performing primary controller duties.

	1	2	3	4	5	6	7
	Decreased Complexity	<<<	<<<	No Effect	>>>	>>>	Inccreased Complexity
26 – Lake					x		
29 – Wayne				x			
45 - Geauga						x	

Was there any one UAV-related event in the scenario that was of note? If so, briefly describe the circumstances and any action you may have taken. Examples of an "event" include a loss of communications with a UAV, a UAV-UAV conflict, a UAV-piloted aircraft conflict, etc.

26 – Lake	GH diverted to DOGGS requesting descent from FL500 to FL430. I had traffic so I stepped him down.
29 – Wayne	Nothing to note
45 - Geauga	No event, just extra clutter on the screen due to amount of data blocks.

What, if anything, was the most complex, difficult, or challenging element in having UAVs present in the scenario just completed? Briefly describe, please.

26 – Lake	Scanning for traffic
29 – Wayne	-
45 - Geauga	Challenging element was slow moving aircraft following grid, making sure handoffs or point outs are made.

Did any UAV-related activity or event impact operational safety in the scenario just completed? If so, please describe the circumstances and context, as well as any action you may have taken.

26 – Lake	no
29 – Wayne	-
45 - Geauga	no

Is there a procedural, operational, or phraseology change that might have proved useful in dealing with any UAV-related challenge experienced in the scenario just completed?

26 – Lake	no
29 – Wayne	-
45 - Geauga	no

Any other comments or observations related to the scenario just completed?

26 – Lake	
29 – Wayne	-
45 - Geauga	no

Participant Controller Post Run Questionnaire – Access 5

Date/Time: 07.14.2005/1130AM PST Scenario #: 8

Please rate the traffic load. Consider aircraft volume, route complexity, impact of UAVs, and any other factors you believe relevant.

	1	2	3	4	5	6	7
	Very Low	Low	Somewhat Low	Average	Somewhat High	High	Very High
26 – Lake							x
29 - Wayne							x
45 - Geauga						x	

To what degree did the presence of UAVs in the scenario affect the complexity of performing primary controller duties.

	1	2	3	4	5	6	7
	Decreased Complexity	<<<	<<<	No Effect	>>>	>>>	Inccreased Complexity
26 – Lake						x	
29 – Wayne						x	
45 - Geauga							x

Was there any one UAV-related event in the scenario that was of note? If so, briefly describe the circumstances and any action you may have taken. Examples of an "event" include a loss of communications with a UAV, a UAV-UAV conflict, a UAV-piloted aircraft conflict, etc.

26 – Lake	An Altair went to hold @ DOLFN @ FL450 he requested FL430 which I gave him but had to watch a Perseus very closely which passed 7 miles behind after Altair speed dropped from 261 to 160 Kts. I had to vector 2 JFK landers around the Altair.
29 – Wayne	Conflicting (or potential) UAVs took some time to analyze. Used altitude to ensure they were separated.
45 - Geauga	No event problems, just slow moving UAVs and keeping data tags from overlapping.

What, if anything, was the most complex, difficult, or challenging element in having UAVs present in the scenario just completed? Briefly describe, please.

26 – Lake	The sheer volume of traffic.
29 – Wayne	Analyzing slow speeds for potential conflict. Also, having 3 sectors involved near boundaries was a complexity issue.
45 - Geauga	Just having heavy traffic and slow moving UAVs makes situational awareness more important and increased.

Did any UAV-related activity or event impact operational safety in the scenario just completed? If so, please describe the circumstances and context, as well as any action you may have taken.

26 – Lake	I would like to see my Union rep before I answer this question.
29 – Wayne	No impact on operational safety.
45 - Geauga	No safety problems.

Is there a procedural, operational, or phraseology change that might have proved useful in dealing with any UAV-related challenge experienced in the scenario just completed?

26 – Lake	
29 – Wayne	-
45 - Geauga	no

Any other comments or observations related to the scenario just completed?

26 – Lake	
29 – Wayne	This was a very busy scenario, it would have been extremely challenging had the activity continued later into the problem.
45 - Geauga	If UAVs were at FL370 or FL390 this would have been extremely complex.

Appendix G: Contingency Management AOS Controller Questionnaires

Participant Controller Post Run Questionnaire – Access 5

Date/Time: 09.15.2005/9AM PST Scenario #: 1

Please rate the traffic load. Consider aircraft volume, route complexity, impact of UAVs, and any other factors you believe relevant.

	1	2	3	4	5	6	7
	Very Low	Low	Somewhat Low	Average	Somewhat High	High	Very High
26 – Lake				x			
29 - Wayne						x	
45 - Geauga				x			

To what degree did the presence of UAVs in the scenario affect the complexity of performing primary controller duties.

	1	2	3	4	5	6	7
	Decreased Complexity	<<<	<<<	No Effect	>>>	>>>	Inccreased Complexity
26 – Lake					x		
29 – Wayne				x			
45 - Geauga				x			

Was there any one UAV-related event in the scenario that was of note? If so, briefly describe the circumstances and any action you may have taken. Examples of an "event" include a loss of communications with a UAV, a UAV-UAV conflict, a UAV-piloted aircraft conflict, etc.

26 – Lake	Slow moving Altair at FL430 was a potential conflict with 2 aircraft, and 1 UAV. I climbed the 2 aircraft to FL450 through JHW Sector. And offered the Globalhawk a climb to FL450 or offset route. He chose the climb.
29 – Wayne	no
45 - Geauga	Loss of communications, then diverted to alternate destination.

What, if anything, was the most complex, difficult, or challenging element in having UAVs present in the scenario just completed? Briefly describe, please.

26 – Lake	It was rather routine.
29 – Wayne	UAVs were overflights – and even though 1 was slow-moving, they had very little impact. Only a slight jog in the traffic search was noticed.
45 - Geauga	No elements were a problem.

Did any UAV-related activity or event impact operational safety in the scenario just completed? If so, please describe the circumstances and context, as well as any action you may have taken.

26 – Lake	no
29 – Wayne	no
45 - Geauga	No safety issues.

Did an ROA contingency occur in your sector during this scenario? If so, please rate the severity of each contingency, indicate what actions you took to manage it, and describe any issues with the procedures employed by the ROA.

ROA Involved:

	1	2	3	4	5	6	7
	Very Minor	Minor	Somewhat Minor	Average	Somewhat Major	Major	Very Major
26 – Lake							
29 - Wayne							
45 - Geauga		x					

Comments:

26 – Lake	
29 – Wayne	
45 - Geauga	Loss of communications, then divert to ground station's requested impact, minimal impact to sector workload.

ROA Involved:

	1	2	3	4	5	6	7
	Very Minor	Minor	Somewhat Minor	Average	Somewhat Major	Major	Very Major
26 – Lake							
29 - Wayne							
45 - Geauga							

Comments:

26 – Lake	
29 – Wayne	
45 - Geauga	

Any other comments or observations related to the scenario just completed?

26 – Lake	
29 – Wayne	
45 - Geauga	No problems, very comfortable with UAVs in sector.

Participant Controller Post Run Questionnaire – Access 5

Date/Time: 09.13.2005/ 2PM PST Scenario #: 2

Please rate the traffic load. Consider aircraft volume, route complexity, impact of UAVs, and any other factors you believe relevant.

	1	2	3	4	5	6	7
	Very Low	Low	Somewhat Low	Average	Somewhat High	High	Very High
26 – Lake					x		
29 - Wayne				x			
45 - Geauga				x			

To what degree did the presence of UAVs in the scenario affect the complexity of performing primary controller duties.

	1	2	3	4	5	6	7
	Decreased Complexity	<<<	<<<	No Effect	>>>	>>>	Inccreased Complexity
26 – Lake						x	
29 – Wayne					x		
45 - Geauga				x			

Was there any one UAV-related event in the scenario that was of note? If so, briefly describe the circumstances and any action you may have taken. Examples of an "event" include a loss of communications with a UAV, a UAV-UAV conflict, a UAV-piloted aircraft conflict, etc.

26 – Lake	UAV-UUAV conflict both at FL430, I descended one to FL400, the UAV @ FL400 went lost comm., lost data link. I affected proper coordination with my supervisor and adjacent airspace (controllers) then vectored possible conflicting traffic around him.
29 – Wayne	No comm. w/ PRSB1 – contacted supervisor – acft returned to freq.
45 - Geauga	One UAV aircraft in hold at CXR drifted out of pattern to the northwest. When questioned pilot recovered to correct pattern.

What, if anything, was the most complex, difficult, or challenging element in having UAVs present in the scenario just completed? Briefly describe, please.

26 – Lake	No D-side to help with coordinating.
29 – Wayne	Challenge keeping slow moving N & S bound acft in scan since this is a predominately E-W sector.
45 - Geauga	No elements in this problem. Only coordination was increased by aircraft out of holding pattern and impacting adjacent sectors.

Did any UAV-related activity or event impact operational safety in the scenario just completed? If so, please describe the circumstances and context, as well as any action you may have taken.

26 – Lake	It distracted me to a potential systems deviation.
29 – Wayne	no
45 - Geauga	no

Did an ROA contingency occur in your sector during this scenario? If so, please rate the severity of each contingency, indicate what actions you took to manage it, and describe any issues with the procedures employed by the ROA.

ROA Involved:

	1	2	3	4	5	6	7
	Very Minor	Minor	Somewhat Minor	Average	Somewhat Major	Major	Very Major
26 – Lake					x		
29 - Wayne	x						
45 - Geauga							

Comments:

26 – Lake	I would have preferred to have had a better idea of what the UAV was doing sooner
29 – Wayne	Minor loss of comm. for short period. When acft did not perform lost comm. proc. Supervisor got him back to freq.
45 - Geauga	

ROA Involved:

	1	2	3	4	5	6	7
	Very Minor	Minor	Somewhat Minor	Average	Somewhat Major	Major	Very Major
26 – Lake							
29 - Wayne							
45 - Geauga							

Comments:

26 – Lake	
29 – Wayne	
45 - Geauga	

Any other comments or observations related to the scenario just completed?

26 – Lake	
29 – Wayne	
45 - Geauga	no

Participant Controller Post Run Questionnaire – Access 5

Date/Time: 09.14.2005/ 9AM PST Scenario #: 3

Please rate the traffic load. Consider aircraft volume, route complexity, impact of UAVs, and any other factors you believe relevant.

	1	2	3	4	5	6	7
	Very Low	Low	Somewhat Low	Average	Somewhat High	High	Very High
26 – Lake			x				
29 - Wayne				x			
45 - Geauga				x			

To what degree did the presence of UAVs in the scenario affect the complexity of performing primary controller duties.

	1	2	3	4	5	6	7
	Decreased Complexity	<<<	<<<	No Effect	>>>	>>>	Inccreased Complexity
26 – Lake					x		
29 – Wayne				x			
45 - Geauga				x			

Was there any one UAV-related event in the scenario that was of note? If so, briefly describe the circumstances and any action you may have taken. Examples of an "event" include a loss of communications with a UAV, a UAV-UAV conflict, a UAV-piloted aircraft conflict, etc.

26 – Lake	
29 – Wayne	Route change GHWK – little impact, Lost nav Perseus – little impact.
45 - Geauga	Global Hawk had route change request then com failure which dissentigrated to lost com contingency. Perseus 1 had navigation problem then diverted. Altair flight requested route short cut.

What, if anything, was the most complex, difficult, or challenging element in having UAVs present in the scenario just completed? Briefly describe, please.

26 – Lake	Other than monitoring the holding UAV and working the overflight UAV, it was rather routine.
29 – Wayne	-
45 - Geauga	Increased coordination between sectors and supervisor.

Did any UAV-related activity or event impact operational safety in the scenario just completed? If so, please describe the circumstances and context, as well as any action you may have taken.

26 – Lake	no
29 – Wayne	no
45 - Geauga	No safety issues, just increased sector workload due to coordination.

Did an ROA contingency occur in your sector during this scenario? If so, please rate the severity of each contingency, indicate what actions you took to manage it, and describe any issues with the procedures employed by the ROA.

ROA Involved:

	1	2	3	4	5	6	7
	Very Minor	Minor	Somewhat Minor	Average	Somewhat Major	Major	Very Major
26 – Lake							
29 - Wayne	x						
45 - Geauga					x		

Comments:

26 – Lake	
29 – Wayne	Perseus with lost nav put on vector
45 - Geauga	Increased coordination was only workload issue.

ROA Involved:

	1	2	3	4	5	6	7
	Very Minor	Minor	Somewhat Minor	Average	Somewhat Major	Major	Very Major
26 – Lake							
29 - Wayne							
45 - Geauga							

Comments:

26 – Lake	
29 – Wayne	
45 - Geauga	

Any other comments or observations related to the scenario just completed?

26 – Lake	
29 – Wayne	
45 - Geauga	Getting more comfortable with these aircraft and their possible problems.

Participant Controller Post Run Questionnaire – Access 5

Date/Time: 09.14.2005/ 130PM PST Scenario #: 4

Please rate the traffic load. Consider aircraft volume, route complexity, impact of UAVs, and any other factors you believe relevant.

	1	2	3	4	5	6	7
	Very Low	Low	Somewhat Low	Average	Somewhat High	High	Very High
26 – Lake			x				
29 - Wayne					x		
45 - Geauga				x			

To what degree did the presence of UAVs in the scenario affect the complexity of performing primary controller duties.

	1	2	3	4	5	6	7
	Decreased Complexity	<<<	<<<	No Effect	>>>	>>>	Inccreased Complexity
26 – Lake					x		
29 – Wayne					x		
45 - Geauga				x			

Was there any one UAV-related event in the scenario that was of note? If so, briefly describe the circumstances and any action you may have taken. Examples of an "event" include a loss of communications with a UAV, a UAV-UAV conflict, a UAV-piloted aircraft conflict, etc.

26 – Lake	UAV went NORDO. I had already handed off to Sector 45, so I coordinated it. UAV returned to my freq near Sectors 45 & 26 boundary, so I gave the com change. Early in the scenario a slow UAV @ FL430 with opposite direction FL430 traffic. I descended the UAV to FL400.
29 – Wayne	UAV return to base. No action necessary except coordination.
45 - Geauga	No, just point outs to north of my airspace from UAVs on missions near mutual sector boundaries.

What, if anything, was the most complex, difficult, or challenging element in having UAVs present in the scenario just completed? Briefly describe, please.

26 – Lake	
29 – Wayne	Small increase in complexity.
45 - Geauga	none

Did any UAV-related activity or event impact operational safety in the scenario just completed? If so, please describe the circumstances and context, as well as any action you may have taken.

26 – Lake	no
29 – Wayne	no
45 - Geauga	no

Did an ROA contingency occur in your sector during this scenario? If so, please rate the severity of each contingency, indicate what actions you took to manage it, and describe any issues with the procedures employed by the ROA.

ROA Involved:

	1	2	3	4	5	6	7
	Very Minor	Minor	Somewhat Minor	Average	Somewhat Major	Major	Very Major
26 – Lake							
29 - Wayne	x						
45 - Geauga							

Comments:

26 – Lake	
29 – Wayne	Lost com, RTB
45 - Geauga	

ROA Involved:

	1	2	3	4	5	6	7
	Very Minor	Minor	Somewhat Minor	Average	Somewhat Major	Major	Very Major
26 – Lake							
29 - Wayne							
45 - Geauga							

Comments:

26 – Lake	
29 – Wayne	
45 - Geauga	

Any other comments or observations related to the scenario just completed?

26 – Lake	
29 – Wayne	
45 - Geauga	Getting more comfortable with this traffic in the airspace

Participant Controller Post Run Questionnaire – Access 5

Date/Time: 09.15.2005/12PM PST Scenario #: 5

Please rate the traffic load. Consider aircraft volume, route complexity, impact of UAVs, and any other factors you believe relevant.

	1	2	3	4	5	6	7
	Very Low	Low	Somewhat Low	Average	Somewhat High	High	Very High
26 – Lake			x				
29 - Wayne				x			
45 - Geauga				x			

To what degree did the presence of UAVs in the scenario affect the complexity of performing primary controller duties.

	1	2	3	4	5	6	7
	Decreased Complexity	<<<	<<<	No Effect	>>>	>>>	Inccreased Complexity
26 – Lake				x			
29 – Wayne					x		
45 - Geauga				x			

Was there any one UAV-related event in the scenario that was of note? If so, briefly describe the circumstances and any action you may have taken. Examples of an "event" include a loss of communications with a UAV, a UAV-UAV conflict, a UAV-piloted aircraft conflict, etc.

26 – Lake	no
29 – Wayne	Perseus losing altitude. Vectored 1 acft out from under until scope of problem was known.
45 - Geauga	1) Loss of communications then aircraft diverted to ground station's preplanned route.

What, if anything, was the most complex, difficult, or challenging element in having UAVs present in the scenario just completed? Briefly describe, please.

26 – Lake	Routine operation
29 – Wayne	I seemed to have data block positioning problems.
45 - Geauga	No problems.

Did any UAV-related activity or event impact operational safety in the scenario just completed? If so, please describe the circumstances and context, as well as any action you may have taken.

26 – Lake	no
29 – Wayne	no
45 - Geauga	No impact to safety.

Did an ROA contingency occur in your sector during this scenario? If so, please rate the severity of each contingency, indicate what actions you took to manage it, and describe any issues with the procedures employed by the ROA.

ROA Involved:

	1	2	3	4	5	6	7
	Very Minor	Minor	Somewhat Minor	Average	Somewhat Major	Major	Very Major
26 – Lake							
29 - Wayne		x					
45 - Geauga		x					

Comments:

26 – Lake	
29 – Wayne	Minor impact since perseus was able to climb back to assigned altitude.
45 - Geauga	Loss of communications, then divert to ground station's preplanned destination. Only actions of coordination were taken care of by area supervisor and ground station.

ROA Involved:

	1	2	3	4	5	6	7
	Very Minor	Minor	Somewhat Minor	Average	Somewhat Major	Major	Very Major
26 – Lake							
29 - Wayne							
45 - Geauga							

Comments:

26 – Lake	
29 – Wayne	
45 - Geauga	

Any other comments or observations related to the scenario just completed?

26 – Lake	
29 – Wayne	
45 - Geauga	Just getting more comfortable with UAVs in the sector.

Participant Controller Post Run Questionnaire – Access 5

Date/Time: 09.14.2005/1030AM PST Scenario #: 6

Please rate the traffic load. Consider aircraft volume, route complexity, impact of UAVs, and any other factors you believe relevant.

	1	2	3	4	5	6	7
	Very Low	Low	Somewhat Low	Average	Somewhat High	High	Very High
26 – Lake						x	
29 - Wayne					x		
45 - Geauga					x		

To what degree did the presence of UAVs in the scenario affect the complexity of performing primary controller duties.

	1	2	3	4	5	6	7
	Decreased Complexity	<<<	<<<	No Effect	>>>	>>>	Inccreased Complexity
26 – Lake						x	
29 – Wayne					x		
45 - Geauga					x		

Was there any one UAV-related event in the scenario that was of note? If so, briefly describe the circumstances and any action you may have taken. Examples of an "event" include a loss of communications with a UAV, a UAV-UAV conflict, a UAV-piloted aircraft conflict, etc.

26 – Lake	Altair emergency lost engine power. The conflicting aircraft were vectored around him.
29 – Wayne	GHWK Lost comm./link – no impact. Altair emergency in 26 – since my traffic was conflicting w/ descent, 2 acft put on vectors.
45 - Geauga	3 events which caused increased coordination between 3 sectors. One engine out aircraft that caused biggest coordination.

What, if anything, was the most complex, difficult, or challenging element in having UAVs present in the scenario just completed? Briefly describe, please.

26 – Lake	There was some confusion when I thought I gave a 320 deg heading to one aircraft and another aircraft took the heading.
29 – Wayne	Since altair was so slow & descending so slow, acft just needed to be vectored away from the area.
45 - Geauga	Just increased coordination because of closeness to sector boundaries. All sectors were quite busy with normal overflight traffic.

Did any UAV-related activity or event impact operational safety in the scenario just completed? If so, please describe the circumstances and context, as well as any action you may have taken.

26 – Lake	no
29 – Wayne	no
45 - Geauga	Safety not a problem, just increased workload due to coordination.

Did an ROA contingency occur in your sector during this scenario? If so, please rate the severity of each contingency, indicate what actions you took to manage it, and describe any issues with the procedures employed by the ROA.

ROA Involved:

	1	2	3	4	5	6	7
	Very Minor	Minor	Somewhat Minor	Average	Somewhat Major	Major	Very Major
26 – Lake						x	
29 - Wayne	x						
45 - Geauga					x		

Comments:

26 – Lake	I vectored aircraft around the emergency UA.V and affected proper coordination
29 – Wayne	GHWK lost com/link.
45 - Geauga	Sector coordination increased due to UAV problems. Would have used extra help at sector with coordination (D-side).

ROA Involved:

	1	2	3	4	5	6	7
	Very Minor	Minor	Somewhat Minor	Average	Somewhat Major	Major	Very Major
26 – Lake							
29 - Wayne						x	
45 - Geauga							

Comments:

26 – Lake	
29 – Wayne	Altair in Sector 26 – vectored my aircraft that were entering sector 26 around the descent area.
45 - Geauga	

Any other comments or observations related to the scenario just completed?

26 – Lake	
29 – Wayne	
45 - Geauga	Just getting more comfortable with characteristics of the UAV aircraft.

Participant Controller Post Run Questionnaire – Access 5

Date/Time: 09.14.2005/ 3PM PST Scenario #: 7

Please rate the traffic load. Consider aircraft volume, route complexity, impact of UAVs, and any other factors you believe relevant.

	1	2	3	4	5	6	7
	Very Low	Low	Somewhat Low	Average	Somewhat High	High	Very High
26 – Lake					x		
29 - Wayne				x			
45 - Geauga				x			

To what degree did the presence of UAVs in the scenario affect the complexity of performing primary controller duties.

	1	2	3	4	5	6	7
	Decreased Complexity	<<<	<<<	No Effect	>>>	>>>	Inccreased Complexity
26 – Lake						x	
29 – Wayne				x			
45 - Geauga				x			

Was there any one UAV-related event in the scenario that was of note? If so, briefly describe the circumstances and any action you may have taken. Examples of an "event" include a loss of communications with a UAV, a UAV-UAV conflict, a UAV-piloted aircraft conflict, etc.

26 – Lake	#3 UAV lost engine @ FL500 & couldn't hold a heading so I vectored #4 UAV out from under him. At different times, both UAVs had either radio or nav problems. I vectored numerous aircraft around #3.
29 – Wayne	Lost comm. – only action required was coordination, with supe & next sector..
45 - Geauga	No events, no problems

What, if anything, was the most complex, difficult, or challenging element in having UAVs present in the scenario just completed? Briefly describe, please.

26 – Lake	In real life, if an aircraft can't maintain altitude he won't ask for a hard altitude assignment… #3 UAV requested FL400.
29 – Wayne	Little impact
45 - Geauga	No problems

Did any UAV-related activity or event impact operational safety in the scenario just completed? If so, please describe the circumstances and context, as well as any action you may have taken.

26 – Lake	no
29 – Wayne	no
45 - Geauga	No safety issues

Did an ROA contingency occur in your sector during this scenario? If so, please rate the severity of each contingency, indicate what actions you took to manage it, and describe any issues with the procedures employed by the ROA.

ROA Involved:

	1	2	3	4	5	6	7
	Very Minor	Minor	Somewhat Minor	Average	Somewhat Major	Major	Very Major
26 – Lake							
29 - Wayne		x					
45 - Geauga							

Comments:

26 – Lake	
29 – Wayne	Lost comm., info relayed thru supe, turn and return to base.
45 - Geauga	

ROA Involved:

	1	2	3	4	5	6	7
	Very Minor	Minor	Somewhat Minor	Average	Somewhat Major	Major	Very Major
26 – Lake							
29 - Wayne							
45 - Geauga							

Comments:

26 – Lake	
29 – Wayne	
45 - Geauga	

Any other comments or observations related to the scenario just completed?

26 – Lake	
29 – Wayne	
45 - Geauga	No comments.

Participant Controller Post Run Questionnaire – Access 5

Date/Time: 09.13.2005/4PM PST Scenario #: 8

Please rate the traffic load. Consider aircraft volume, route complexity, impact of UAVs, and any other factors you believe relevant.

	1	2	3	4	5	6	7
	Very Low	Low	Somewhat Low	Average	Somewhat High	High	Very High
26 – Lake				x			
29 - Wayne				x			
45 - Geauga				x			

To what degree did the presence of UAVs in the scenario affect the complexity of performing primary controller duties.

	1	2	3	4	5	6	7
	Decreased Complexity	<<<	<<<	No Effect	>>>	>>>	Inccreased Complexity
26 – Lake					x		
29 – Wayne				x			
45 - Geauga				x			

Was there any one UAV-related event in the scenario that was of note? If so, briefly describe the circumstances and any action you may have taken. Examples of an "event" include a loss of communications with a UAV, a UAV-UAV conflict, a UAV-piloted aircraft conflict, etc.

26 – Lake	I observed a UAV @ FL427 descending when FL430 was assigned. I questioned him & he climbed back to FL430.
29 – Wayne	-
45 - Geauga	Emergency loss of power, divert to airport of pilot request, slow mving descent in holding pattern, numerous vectors to surrounding aircraft to clear area of holding pattern.

What, if anything, was the most complex, difficult, or challenging element in having UAVs present in the scenario just completed? Briefly describe, please.

26 – Lake	
29 – Wayne	-
45 - Geauga	Slow moving descent in holding pattern, basically sterilize the area around this aircraft

Did any UAV-related activity or event impact operational safety in the scenario just completed? If so, please describe the circumstances and context, as well as any action you may have taken.

26 – Lake	No
29 – Wayne	-
45 - Geauga	Safety not compromised, overall sector workload increased due special attention to emergency.

Did an ROA contingency occur in your sector during this scenario? If so, please rate the severity of each contingency, indicate what actions you took to manage it, and describe any issues with the procedures employed by the ROA.

ROA Involved:

	1	2	3	4	5	6	7
	Very Minor	Minor	Somewhat Minor	Average	Somewhat Major	Major	Very Major
26 – Lake							
29 - Wayne							
45 - Geauga						x	

Comments:

26 – Lake	
29 – Wayne	
45 - Geauga	Loss of power, emergency declared, divert to pilot requested airport. Aircraft advised all intentions very timely.

ROA Involved:

	1	2	3	4	5	6	7
	Very Minor	Minor	Somewhat Minor	Average	Somewhat Major	Major	Very Major
26 – Lake							
29 - Wayne							
45 - Geauga							

Comments:

26 – Lake	
29 – Wayne	
45 - Geauga	

Any other comments or observations related to the scenario just completed?

26 – Lake	After the UAV demonstrated he couldn't hold altitude, I spent a lot of time doing mental gymnastics formulating what-if scenarios if he lost altitude again.
29 – Wayne	
45 - Geauga	no

Participant Controller Post Run Questionnaire – Access 5

Date/Time:09.15.2005/2PM PST Scenario #: 9

Please rate the traffic load. Consider aircraft volume, route complexity, impact of UAVs, and any other factors you believe relevant.

	1	2	3	4	5	6	7
	Very Low	Low	Somewhat Low	Average	Somewhat High	High	Very High
26 – Lake				x			
29 - Wayne			x				
45 - Geauga				x			

To what degree did the presence of UAVs in the scenario affect the complexity of performing primary controller duties.

	1	2	3	4	5	6	7
	Decreased Complexity	<<<	<<<	No Effect	>>>	>>>	Inccreased Complexity
26 – Lake					x		
29 – Wayne				x			
45 - Geauga				x			

Was there any one UAV-related event in the scenario that was of note? If so, briefly describe the circumstances and any action you may have taken. Examples of an "event" include a loss of communications with a UAV, a UAV-UAV conflict, a UAV-piloted aircraft conflict, etc.

26 – Lake	Altair 3 @ FL430, I vectored a Gulfstream 4 around the Altair.
29 – Wayne	Lost com GHWK – no impact
45 - Geauga	1) Loss of communications and return to base. 2) Loss of navigational equipment (GPS), then return to base.

What, if anything, was the most complex, difficult, or challenging element in having UAVs present in the scenario just completed? Briefly describe, please.

26 – Lake	The G-4 was given direct JHW-VOR (about a 100 deg heading). The G-4 turned to about a 130 deg heading with a possible confliction with the Altair, so I had to put the G-4 back on a 080 heading until he was well clear of the Altair.
29 – Wayne	-
45 - Geauga	Loss of navigational equipment (GPS) I had to notice the problem (off course). A call from the pilot advising they were having a problem would have been extremely helpful.

Did any UAV-related activity or event impact operational safety in the scenario just completed? If so, please describe the circumstances and context, as well as any action you may have taken.

26 – Lake	no
29 – Wayne	no
45 - Geauga	No safety issues

Did an ROA contingency occur in your sector during this scenario? If so, please rate the severity of each contingency, indicate what actions you took to manage it, and describe any issues with the procedures employed by the ROA.

ROA Involved:

	1	2	3	4	5	6	7
	Very Minor	Minor	Somewhat Minor	Average	Somewhat Major	Major	Very Major
26 – Lake							
29 - Wayne	x						
45 - Geauga					x		

Comments:

26 – Lake	
29 – Wayne	GHWK transited as a comm. failure.
45 - Geauga	1) Loss of communications return to base, was coordinated through supervisor, only had to update flight plan information to return to base.

ROA Involved:

	1	2	3	4	5	6	7
	Very Minor	Minor	Somewhat Minor	Average	Somewhat Major	Major	Very Major
26 – Lake							
29 - Wayne							
45 - Geauga					x		

Comments:

26 – Lake	
29 – Wayne	
45 - Geauga	Loss of navigation (GPS). I had to notice aircraft off course. Once questioned, pilot requested to return to base.

Any other comments or observations related to the scenario just completed?

26 – Lake	Relatively routine
29 – Wayne	
45 - Geauga	UAV ground station needs to advise of navigational problems sooner.

Appendix H: Simulation Issues Matrix

The Access 5 Integrated Product Team (IPT) Simulation Issues Matrix is a comprehensive inventory of the contingencies (and related issues) proffered by each of the Access 5 IPTs for consideration as candidate simulation evaluation topics. It was compiled to facilitate the identification and articulation of simulation requirements associated with these contingencies, especially with regard to ROA and ATC procedures. Additionally, the Matrix was compiled to support the Simulation IPT in prioritizing and organizing contingency events for inclusion in simulation evaluations. Moreover, the Matrix is to be a tool for determining which simulation environment – Airspace Operations, Air Vehicle Control Station, or Integrated – was most appropriate. The Matrix will also to be used to identify which issues are out of scope for run-time simulation within Access 5. Finally, the Matrix will be used to assist in identifying the possibility of linking contingency simulations with other program assessments. The process for developing the Matrix included extensive IPT collaboration at technical, operational, and policy levels.

Contingency Management Scenario Definition
2-Dec-04

Taxi = ROA speed < rotation or safe stop runway

Functional Category	Failure Category	Failure Cause	Effects	Mitigations	Proposed Recovery Process by Flight Phase
Degraded Ability to Follow ATC Commands	1. Intermittent Reception from ATC	**H/W:** ROA Rcvr/Tx, GCS Rcvr, GCS Audio, OTH **Other:** Freq, Wx	(A) Slow response to ATC direction – Repeat of ATC calls required (B) Wrong Response to ATC direction – Misinterpreted ATC calls	(1) Same as piloted aircraft. (2) Resort to phone line if problem presists.	Taxi: Confirm control authority otherwise immediately apply brakes, wait 1 minute – pending secure link acquisition proceed on planned course or power down, GND crew safe ROA, tow Take-off, Enroute, Landing: (1) ROC and ATC establish ROA intent for course, speed, altitude matches other input, radar, sightings, etc. – ATC confirm against its own sources (2) ROC notify ATC by other means, changing frequency in accordance with policy, ATC advise other traffic/ROC, provide clearance in flight path to nearest landing sites (3) Re-aquired communications – proceed on flight plan, otherwise broadcast "lost Link" code until re-acquired and:
	2. No Reception from ATC	**H/W:** ROA Rcvr/Tx, GCS Rcvr, GCS Audio, OTH **Other:** Freq, Wx	(A) Inability for ROC to follow ATC direction	same as above	same as solution for H/W, freq, Wx above
	3. False Reception from ATC	**Spoofing**	(A) Wrong response to ATC direction (B) ATC may have less awareness of this situation than in the piloted aircraft case (less likelihood that ATC will hear spoofing transmissions)		

Figure 1: Sample Page from Original Contingency Management IPT Issues Matrix

The IPT Issues Matrix was developed by the Simulation IPT by modifying and extending the contingency matrix created by the Contingency Management IPT (Figure 1). Modifications to the original Contingency Management IPT matrix include minor alterations such as category changes (i.e., "Failure Category" was changed to "Issue," "Failure Cause" became "Situational Precursor"), and the addition of suggested simulation venues (Airspace Operations, Air Vehicle

Control Station, or Integrated simulation: Figure 2). The Matrix provided open sections for each relevant IPT (Command, Control, and Communications; Cooperative Collision Avoidance; Human-Systems Interface (representing other Technology elements); ROA Impact; and Policy). The Matrix was distributed to these IPTs in late May/early June of 2005, along with a cover letter soliciting IPT response by the end of June. The IPTs were invited to respond either within the matrix template, or in any format they believed was more appropriate.

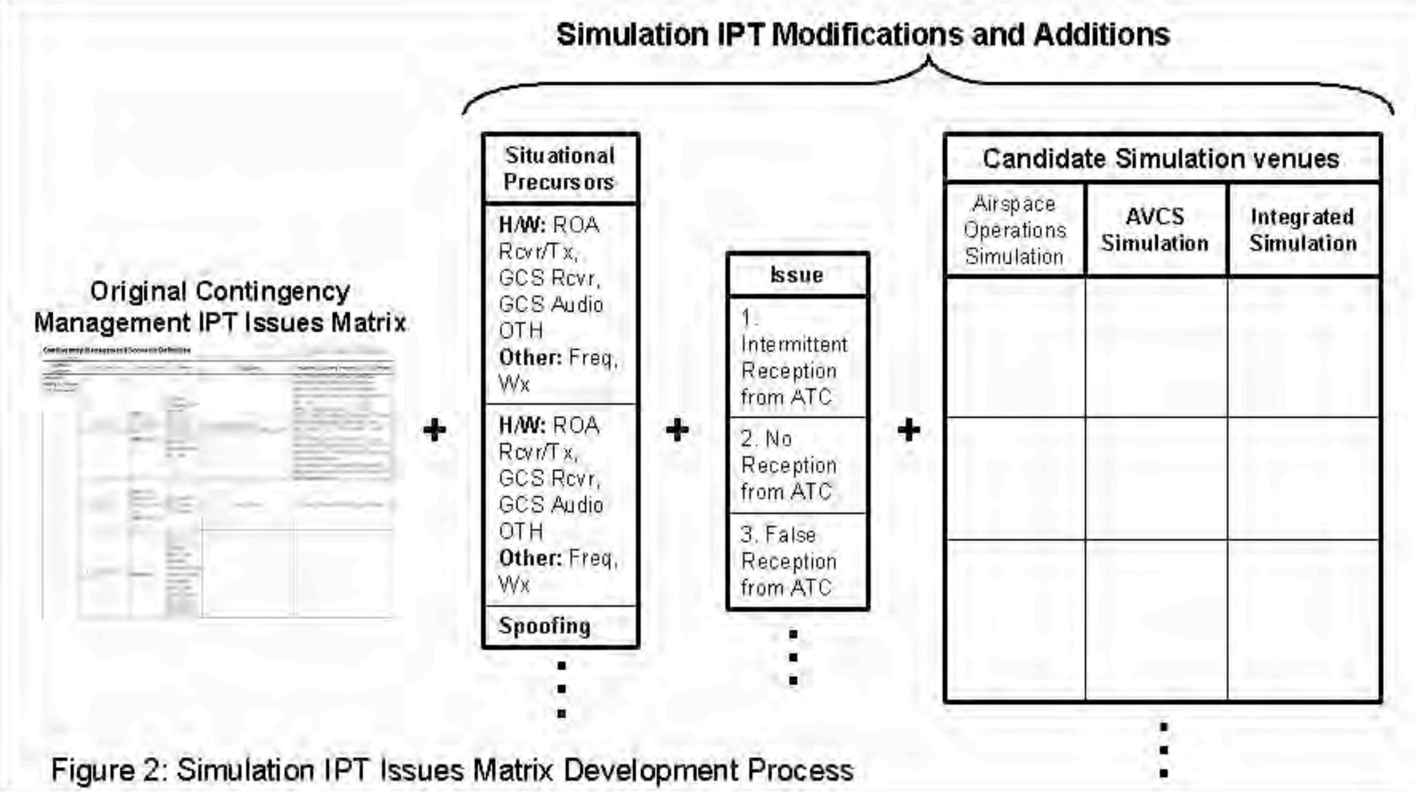


Figure 2: Simulation IPT Issues Matrix Development Process

Upon receipt of inputs from the IPTs, the Simulation IPT collated the contingency events, and began to consider which simulation venue – Airspace Operations, Air Vehicle Control Station, or Integrated – might most appropriately be used for evaluation. Contingency elements were also preliminarily evaluated for mission criticality, suitability with other operational constraints (airspace characteristics, ATC activities, etc.), and how they might potentially occur in concert with other operational events and contingencies. This initial prioritization activity was pursued far enough to support decisions for the 2005 simulation sessions. A more extensive (and IPT – collaborative) prioritization is planned for early 2006.

IPT	Functional Category	Issue	Situational Precursors	Effects	Issue Mitigation Efforts
CM	Degraded Ability to Follow ATC Commands	1. Intermittent Reception from ATC	H/W: ROA Rcvr/Tx, GCS Rcvr, GCS Audio OTH Other: Freq, Wx	(A) Slow response to ATC direction - Repeat ATC calls required. (B) Wrong response to ATC direction - Misinterpreted ATC calls.	(1) Same as piloted aircraft. (2) Resort to phone line if problem persists.
CCA	Situational Awareness System failure	1. Intruder systems, UAS sensor system, or display fails and UAS pilot unable to maintain situational awareness of intruder aircraft	(A) UAS sensor (B) Unequipped intruder (C) Intruder data link failure (D) Display/Display logic	(A) failure to identify potential collision (B) mid air collision (C) slow pilot response to conflict	(1) redundancy: (2) multiple sensors (3) multiple data paths (4) hardware
C3	The C2 Communications System shall use the uplink to transfer information from the AVCS to the UA.	1. The AVCS must be able to provide information to the UA regarding flight instructions.	AVCS issues an instruction to the UA.	The UA will adjust its flight based on information received from the AVCS.	Retransmission will occur after a predetermined time interval.
C3/HSI.	HSI/C3-1: Pilot-ATC voice latency effects on operations (to be coordinated with C3)	1. What are the operational impacts for BLOS voice communication latencies between an UA pilot and air traffic controller for operations above FL180?	Pilot to ATC communication and ATC to pilot communication	Different latencies will affect, or will not affect, operational communications between the pilot and ATC. Large latencies will negatively affect communications and safety.	Determine the operational impact threshold for BLOS voice communications latency between an UA pilot and air traffic controller for operations above FL180.
HSI	Degraded Ability to Follow ATC Commands	What are the opeartional impacts of loss of BLOS communications between ROA pilot and ATC?			Examine procedural options for ROA flight during loss of communications. Observe pilot tasks and impact on ATC. Procedural options include (1) diversion to nearest suitable airport, (2) return to origin, and (3) continuance to destination.
SIM	Multiple Contingencies	1. Complete loss of ATC-Pilot communication, and complete loss of command link.	H/W: flight controls. Power, landing gear S/W: control, route following, auto-landing	(A) ROA in the wrong airspace. (B) ROA slow or unable to respond to ATC direction.	(1) Extensive class A level testing. (2) Redundant OA systems. (3) Effective "voting" scheme to identify and ignore failed components.
POLICY	Degraded Ability to Follow ATC Commands	1. Intermittent Reception from ATC	H/W: ROA Rcvr/Tx, GCS Rcvr, GCS Audio OTH Other: Freq, Wx	(A) Slow response to ATC direction - Repeat ATC calls required. (B) Wrong response to ATC direction - Misinterpreted ATC calls.	(1) Same as piloted aircraft. (2) Resort to phone line if problem persists.

Figure 3: IPT Simulation Issues Matrix: Per IPT Examples of Candidates and Related Factors

With the collection and integration of candidate contingency events into the IPT Simulation Issues Matrix (Figure 3), and the preliminary identification of the appropriate simulation venues for at least some of these contingencies, the Simulation IPT was able to incorporate a number of high-priority issues into the first contingency management airspace operations simulation in September, 2005. The following contingencies were examined:

- Single failures/events:
  - Temporary communications reception failure between the ROA Pilot and Air Traffic Controller
  - Complete communications failure between the ROA Pilot and Air Traffic Controller
  - Temporary command/status link failure between the ROA Pilot and the ROA

- Complete command/status link failure between the ROA Pilot and the ROA
    - ROA experiencing temporary loss of engine performance
    - ROA experiencing complete loss of engine performance
    - ROA experiencing partial turbocharger failure (causing partial loss of power)
    - ROA performing uncommanded flight plan deviations
    - ROA performing uncommanded altitude deviations
    - ROA cruise speed being substantially slower than overtaking traffic
- Multiple failures:
    - Complete communications failure between the ROA Pilot and Air Traffic Controller, <u>and</u> complete command/status link failure between ROA pilot and ROA

Appendix H.1: IPT Simulation Issues Matrix – Original Compilation
Appendix H.2: IPT Simulation Issues Matrix – Candidate Contingencies and Related Issues
Appendix H.3: IPT Simulation Issues Sorted by Function – (Highlighted Elements Addressed in First Contingency AOS)

APPENDIX X1: IPT Simulation Issues Matrix - Original Compilation

IPT	Functional Category	Issue	Situational Precursors	Effects	Issue Mitigation Efforts
CM	**Degraded Ability to Follow ATC Commands**	1. Intermittent Reception from ATC	**H/W:** ROA Rcvr/Tx, GCS Rcvr, GCS Audio OTH **Other:** Freq, Wx	(A) Slow response to ATC direction - Repeat ATC calls required. (B) Wrong response to ATC direction - Misinterpreted ATC calls.	(1) Same as piloted aircraft. (2) Resort to phone line if problem persists.
		2. No Reception from ATC	**H/W:** ROA Rcvr/Tx, GCS Rcvr, GCS Audio OTH **Other:** Freq, Wx	(A) Inability for ROC to follow ATC direction	same as above
		3. False Reception from ATC	**Spoofing**	(A) Wrong response to ROA status. (B) ATC may have less awareness of this situation than in the piloted aircraft case (less likelihood that ATC will hear spoofing transmissions).	
		4. Intermittent Reception from ROC	**H/W:** ROA Rcvr/Tx, GCS Rcvr, GCS Audio OTH **Other:** Freq, Wx	(A) Slow response to ATC direction - Repeated requests for ROC response required/higher ATC workload	(1) Same as piloted aircraft. (2) Resort to phone line if problem persists.
		5. No Reception from ROC	**H/W:** ROA Rcvr/Tx, GCS Rcvr, GCS Audio OTH **Other:** Freq, Wx	(A) Slow response to ATC direction - Repeat of ROC calls required. (B) Wrong response to ROC transmissions - Misinterpreted ROC calls.	same as above

APPENDIX X1: IPT Simulation Issues Matrix - Original Compilation

		6. False Reception from ROC	**Spoofing**	(A) Wrong response to ROA status. (B) ATC may have less awareness of this situation than in the piloted aircraft case (less likelihood that ATC will hear spoofing transmissions).	
		7. Loss of ROC to ROA C2	**H/W:** ROA OTH Rcvr/Pwr GCS OTH TX/Pwr **Sat:** Avail, Look, Ang	(A) Potential autonomous operation. (B) No ROA response to ATC direction.	
		8. Loss of ROA to ROC C2	**H/W:** ROA OTH Rcvr/Pwr GCS OTH TX/Pwr **Sat:** Avail, Look, Ang	(A) Loss of ROA situational awareness/status	
		9. False ROC to ROA C2	security violated, EMI	Security violated, EMI	
	Unable to Follow Mission Route Plan	1. Atmospheric Conditions	**Wx/Plume detected:** by ROC, by ROA, by ATC **Winds:** > AV maneuver abilities	(A) Loss of aircraft, mission, and/or life. (B) Delayed mission.	
		2. Obstacle	**Traffic or Birds in Flight Path:** Collision Potential not Detected by ATC	(A) Loss of ROA and other aircraft. (B) Loss of life. (C) Immediate flight path deviation required.	ROA Collision Avoidance System
		3. Erroneous Data	**NAV Position:** On ROA, at ATC, ?display. In GCS **Erroneous Mission Plan Loaded:** Corrupt mission Plan Data	(A) ROA in the wrong airspace	(1) Upload new flight plan. (2) Revert to manual control.
		4. ROA Control Intermittent or Failed	**H/W:** flight controls. Power, landing gear **S/W:** control, route following, auto-landing	(A) ROA in the wrong airspace. (B) ROA slow or unable to respond to ATC direction.	(1) Extensive class A level testing. (2) Redundant OA systems. (3) Effective "voting" scheme to identity and ignore failed components.
		5. ROC Control Intermittent or Failed	**H/W:** C2 displays, operator interact **S/W:** display signal corruption Operator: wrong frequency, bad command (s)	same as above	(1) Extensive class A level testing. (2) Redundant OA systems. (3) Effective "voting" scheme to identity and ignore failed components.
		6. Procedural	**ROC:** data entry **ATC:** erroneous call	(A) ROA in the wrong airspace	

APPENDIX X1: **IPT Simulation Issues Matrix - Original Compilation**

		7. Lack of ATC clearance to continue mission	ATC can't continue to protect ROA airspace	(A) ROA must leave mission plan and divert to unplanned airspace for an undetermined amount of time	
	Inability to Sustain Flight	1. Power Plant	Loss of sufficient thrust	(A) Unplanned mission termination (B) Inability to execute go-around (C) Landing at non-ROA airfield (D) Landing or ditching in an unplanned area. (E) Possible autonomous operation	
		2. Vehicle Flight Control	(A) Software error/fault (B) Hardware degraded/failed (C) Commands exceeds capability (D) External hostility (E) Structural failure	(A) Loss of aircraft, mission, and/or life. (B) Collateral damage people and property on ground.	(1) Extensive class A level testing (2) Redundant systems (3) Effective "voting" scheme to identify and ignore failed components (4) ROA, ROC and ATC components and systems designed and tested to exceed worst case environmental conditions (e.g. salt, fog, Random vibration, humidity, shock, EMI, etc.) (5) Flight Test components as completed system (6) Quality and Reliability pro-active and effective in assuring compliance to requirements (7) Training, design and procedural mitigations to prevent or eliminate potential hazards (8) Secure facilities, encoded command transmissions, feedback mechanisms, and personnel screened (9) Simulation, high fidelity to flight items (10) Effective Configuration Management, baseline before first flight and controlled through all subsequent changes (11) Meaningful corrective action, improvement processes
	Degradation of Situational Awareness due to Loss of Non-Flight Essential System	1. Collision Avoidance	(A) Transponder failure (B) See & avoid system failure		
		2. Aircraft State	(A) Attitude indications (B) Nose camera (C) Air data information (D) Angle-of-attack information		
		3. Safety Systems	Anti-ice		

APPENDIX X1: **IPT Simulation Issues Matrix - Original Compilation**

CCA	**Situational Awareness System failure**	1. Intruder systems, ROAS sensor system, or display fails and ROAS pilot unable to maintain situational awareness of intruder aircraft.	(A) ROAS sensor (B) Unequipped intruder (C) Intruder data link failure (D) Display/Display logic	(A) Failure to identify potential collision (B) Mid air collision (C) Slow pilot response to conflict	(1) Redundancy: (2) Multiple sensors (3) Multiple data paths (4) Hardware
		2. Intermittent reception/ processing of intruder data causes system to fail to track intruder.	same as above	same as above	same as above
		3. Human system interface fails to provide adequate situational awareness to ROAS pilot .	same as above	same as above	same as above
	ROAs interaction with normally-equipped (i.e., TCAS) aircraft in the NAS	1. ROAS has reduced climb capability compared with other traffic.	(A) Controllers/other traffic are unaware of ROAS limited performance	(A) Controller does not realize ROAS cannot climb and issues a climb to the ROAS for avoidance (B) TCAS on intruder issues descend command	(1) Training (2) Procedures (3) Unique ROAS identifiers/call signs
		2. ROAS uses an alternative collision avoidance logic that results in longer look-ahead time than other traffic. Maneuvers before traffic is warned of a conflict and before ATC expects action.	(A) Collision geometry controller does not take action	(A) Controller workload increased to deal with maneuvering ROAS (B) Conflict with other traffic	(1) Limit look-ahead time to minimum required
		3. Excessive link delays cause the ROAS to not respond in sufficient time to resolve a potential collision.	(A) Collision geometry (B) ROAS CAS maneuver command delayed (C) Controller command not followed	(A) Controllers do not notice unexpected ROAS maneuver (B) Potential conflict with other traffic	(1) Add look-ahead time so ROAS maneuvers before TCAS RA
	ROAs pilot behavior	1. ROAS pilot fails to detect intruder aircraft -- ROAS pilot fails to scan display.	(A) Work load (B) Distraction	(A) Slow response to avoidance command	(1) Training (2) Flight procedures (3) Detection logic
		2. ROAS pilot fails to track intruder -- cognitive skills.	(A) Display not intuitive	(A) Slow response to avoidance command (B) Does not respond to maneuver command	
		3. ROAS pilot fails to identify intruder as a threat -- unrecognized collision course.	(A) Multiple intruders (B) Intruder changes course (C) Complex geometry (D) Speed differential	(A) Failure to maneuver to avoid collision	(1) Training (2) Collision detection and alerting logic

APPENDIX X1: IPT Simulation Issues Matrix - Original Compilation

		4. ROAS pilot does not maneuver, maneuvers incorrectly, or maneuvers late -- selected maneuver does not solve conflict.	(A) Intruder maneuver negates avoidance (B) ROAS pilot does not understand geometry (C) Lack of situational awareness	(A) Collision	(1) Training (2) rules of the road (3) collision resolution logic
		5. ROAS pilot does not maneuver, maneuvers incorrectly, or maneuvers late -- ROAS performance.	(A) Speed differential (B) Climb/descend ability		(1) Special procedures for low performance aircraft
	ROAs encounter with other 'low performance' aircraft	1. Two aircraft that cannot climb at TCAS-like rates are on a collision geometry .	(A) Controller is unaware of aircraft limitations (B) No action by pilots or controller to resolve collision potential early	(A) Collision	(1) Training (2) Procedures (3) Unique ROAS identifiers/call signs
C3	**The C2 Communications System shall use the uplink to transfer information from the AVCS to the ROA.**	1. The AVCS must be able to provide information to the ROA regarding flight instructions.	AVCS issues an instruction to the ROA.	The ROA will adjust its flight based on information received from the AVCS.	Retransmission will occur after a predetermined time interval.
	The C2 link shall provide LOS and/or BLOS uplink communications as needed between the ROA and AVCS.	1. The ROA will receive information from the AVCS regardless of its proximity to the AVCS.	AVCS issues an instruction to the ROA.	The ROA will adjust its flight based on information received from the AVCS.	Retransmission will occur after a predetermined time interval.
	The C2 Communications System shall use the downlink to transfer information from the ROA to the AVCS.	1. The ROA must be able to provide information to the AVCS regarding status information.	The ROA acknowledges receipt of a transmission from AVCS or initiates transmission to the AVCS.	The AVCS will receive information from the ROA and provide further instruction.	Retransmission will occur after a predetermined time interval.
	The C2 link shall provide LOS and/or BLOS downlink communications as needed between the ROA and AVCS.	1. The AVCS will receive information from the ROA regardless of its proximity to the ROA.	The ROA acknowledges receipt of a transmission from AVCS or initiates transmission to the AVCS.	The AVCS will receive information from the ROA and provide further instruction.	Retransmission will occur after a predetermined time interval.

APPENDIX X1: IPT Simulation Issues Matrix - Original Compilation

The C2 Communications System shall coordinate the uplink and downlink operations to provide orderly message transfer.	1. This coordination will ensure that both uplink and downlink communications are conducted in a timely manner.	Either the ROA or AVCS initiates a message.	The receiver will acknowledge receipt and respond accordingly.	Standardized "retransmit" procedures should be identified as well as the receiver repeating what was received. IE…descending to FL300, etc.
The C2 Communications System shall maintain message intelligibility during both uplink and downlink operations.	1. This will ensure that message transmission is understood by both parties.	Either the ROA or AVCS transmits a message.	The receiver will acknowledge receipt and respond accordingly.	Standardized "retransmit" procedures should be identified as well as the receiver repeating what was received. IE…descending to FL300, etc.
The C2 Communications System shall provide a means to limit message delivery delays.	1. Messages must be delivered in a timely manner in order to be useful.	A message is sent from either party.	The receiver will acknowledge receipt and respond accordingly.	Standardized "retransmit" procedures should be identified as well as the receiver repeating what was received. IE…descending to FL300, etc.
The C2 Communications System shall provide procedures for data transmission.	1. Data transmission parameters include frequency, data rate, modulation/coding, antenna usage, transmit power, etc.	Due to the complexity of the C2 Communications System, it is expected that selection of data transmission parameters will be automated to achieve effective system performance	Standardized data transmission to ensure accuracy and efficiency.	Follow current standards followed by ROAs during test flights.
Shall not generate harmful interference to other NAS systems	1. The HALE ROA ATC communication system shall not generate harmful interference to other NAS systems such as navigation, landing, and surveillance.	All other aircraft navigating as per normal throughout the NAS.	Can cause issues in separation, etc when the ROA is not mindful of the other aircraft around them, especially since there may be great differences in speed or abilities of the aircraft.	Ensure the contact with ATC is uninterrupted so that no interference is made for other aircraft. If there is a conflict of some kind, the ATC will have to determine what should be done to correct the problem.
Shall operate under the existing RFI environments	1. The HALE ROA ATC Communication system shall operate under the existing RFI environments.	All manned aircraft use the existing RFI environments.	ROA's are coexisting with the rest of air traffic.	No mitigation - this is a requirement.
End-to-End Voice Communications Delay	1. The HALE ROA ATC A/G Communication System shall initiate ATC A/G communications within 250 milliseconds of a pilot PTT event	A pilot initiates the Push to Talk event in order to communicate with ATC.	Delay in communications which could lead to retransmissions, safety issues due to untimely transmissions and heightened frustration levels as well as work load impacts due to retransmissions.	Terrestrial Link and Terrestrial/VHF Hybrid Link should not push the end to end delay over 250 milliseconds. However, ROA Relay probably would not meet the 250 millisecond requirement.

APPENDIX X1: **IPT Simulation Issues Matrix - Original Compilation**

	Communication latencies with ATC	1. Consistent/variable latency	(A) Temporal resolution. (B) Spatial resolution. (C) Color capabilities. (D) Field of view of visual display (E) Operator usability		
C3/HSI.		**HSI/C3-1: Pilot-ATC voice latency effects on operations (to be coordinated with C3)**	1. What are the operational impacts for BLOS voice communication latencies between an ROA pilot and air traffic controller for operations above FL180?	Pilot to ATC communication and ATC to pilot communication	Different latencies will affect, or will not affect, operational communications between the pilot and ATC. Large latencies will negatively affect communications and safety.
		HSI/C3-2. Pilot-ROA communications latency effects on ROA manual flight control (BLOS)(to be coordinated with C3)	1. Can a ROA be flown manually BLOS? Will Access5 dictate that no ROA can be manually flown BLOS?	Basic design of some ROA may require manual flight control. For ROA that do not employ manual control as a basic flight mode, but employ manual control as a reversionary mode, failure of auto flight system causing reversion to manual control.	Latency affects ability of the pilot to satisfactorily control the ROA in flight. Large latencies will negatively affect manual flight control and safety.
HSI	**Degraded Ability to Follow ATC Commands**	1. What are the operational impacts of loss of BLOS communications between ROA pilot and ATC?			Examine procedural options for ROA flight during loss of communications. Observe pilot tasks and impact on ATC.

APPENDIX X1: IPT Simulation Issues Matrix - Original Compilation

	Degraded Ability to Control ROA	1. What are the operational impacts of loss link between pilot and ROA?			Examine procedural options for ROA flight during loss of link. Observe pilot tasks and impact on ATC.
	Collision Avoidance Criticality	1. Is Avoidance Maneuver Guidance Information necessary for satisfactory collision avoidance performance for operations above FL180?			For the Access 5 collision avoidance concept(s), evaluate collision avoidance performance as a function of information presented to the pilot.
	Pilot situational Awareness	1. Information requirements for efficient pilot situational awareness.			
	Pilot Reaction Times	1. Pilot reaction time to collision avoidance traffic alert operations above FL180.			For the Access 5 collision avoidance concept(s), measure pilot reaction time in an operational environment. Thereafter, determine if the observed reaction time data are compatible with collision avoidance concepts. If shorter reaction times are required, perform a second study to determine if the required reaction time is within pilot capabilities.
SIM	**Multiple Contingencies**	1. Complete loss of ATC-Pilot communication, and complete loss of command link.		(A) ROA in the wrong airspace. (B) ROA slow or unable to respond to ATC direction.	
		2. Complete loss of ATC-Pilot communication, and temporary loss of command link.		same as above	
		3. Temporary loss of ATC-Pilot communication, and complete loss of command link.		same as above	
	Degraded Ability to Follow ATC Commands	1. Temporary loss of two-way communication between pilot and ATC		(A) Slow response to ATC direction - Repeat ATC calls required. (B) Wrong response to ATC direction - Misinterpreted ATC calls.	

APPENDIX X1: **IPT Simulation Issues Matrix - Original Compilation**

		2. Complete loss of two-way communication between pilot and ATC		(A) Inability for ROC to follow ATC direction	
	Degraded Ability to Control ROA	1. ROA experiences temporary loss of command link.		(A) Unplanned mission termination (B) Inability to execute go-around (C) Landing at non-ROA airfield (D) Landing or ditching in an unplanned area.	
		2. ROA experiences complete loss of command link.		same as above	
		3. ROA experiences temporary loss of engine performance.		same as above	
		4. ROA experiences complete loss of engine performance.		same as above	
	Degraded Ability to Follow Flight-Plan	1. Unintended route diversion 2. Unintended altitude diversion			
POLICY (Derived from Policy Position Papers)	**Multiple Contingencies**	1. Complete loss of ATC-Pilot communication, and complete loss of command link.		(A) ROA in the wrong airspace. (B) ROA slow or unable to respond to ATC direction.	
		2. Complete loss of ATC-Pilot communication, and temporary loss of command link.		same as above	

APPENDIX X1: IPT Simulation Issues Matrix - Original Compilation

		3. Temporary loss of ATC-Pilot communication, and complete loss of command link.		same as above	
	Communications Issues	1. Temporary loss of two way communication between pilot and ATC		(A) Slow response to ATC direction - Repeat ATC calls required. (B) Wrong response to ATC direction - Misinterpreted ATC calls.	
		2. Complete loss of two-way communication between pilot and ATC		(A) Inability for ROC to follow ATC direction	
	Command/Status Link Issues	1. Temporary command/status link interruption		(A) Unplanned mission termination (B) Inability to execute go-around (C) Landing at non-ROA airfield (D) Landing or ditching in an unplanned area.	
		2. Complete loss of command/status link		(A) Unplanned mission termination (B) Inability to execute go-around (C) Landing at non-ROA airfield (D) Landing or ditching in an unplanned area.	
	Weather Issues	1. Excessive turbulence			
		2. Excessive icing			
	On-Board System Issues	1. Power System failures			(1) Sufficient ROA power system (2) Power system will mange all critical systems during propulsion system failure (3) Backup power systems for all flight critical systems
		2. Propulsion System failure			(1) ROA must be capable to designate and maneuver to Nearest Suitable landing area
		3. Flight Control System failure			(1) Redundant flight controls (2) ROA must notify pilot of complete system failure, change transponder code, and terminate flight
		4. Navigation System failure			(1)Backup navigation system
		5. Payload System failure			(1) Payload system will be isolated from other systems (2) Payload system has the capabilities to immediately shut down
		6. Cooperative Collision Avoidance System failure			

APPENDIX X1: **IPT Simulation Issues Matrix - Original Compilation**

		7. Mechanical or other system failures			

APPENDIX X1: **IPT Simulation Issues Matrix - Original Compilation**

Proposed Operational / System Response
Taxi: Confirm control authority otherwise immediately apply brakes, wait 1 minute - pending secure link acquisition proceed on planned course or power down, GND crew safe ROA, tow Take-off, Enroute, Landing: (1) ROC and ATC establish ROA intent for course, speed, altitude matches other input, radar, sightings, etc. - ATC confirm against its own sources (2) ROC notify ATC by other means, changing frequency in accordance with policy, ATC advise other traffic/ROC, provide clearance in flight path to nearest landing sites (3) Re-acquired communications - proceed on flight plan, otherwise broadcast "lost Link" code until re-acquired and: (3a) ROC declare emergency, ATC advise other traffic (3b) ROC command re-route flight plan to nearest landing site per ATC clearance
same as solution for H/W, freq, Wx above

(1) Request new vector if time permits. (2) Avoid obstacle. (3) Advise ATC.
Resort to backup AVCS if available

APPENDIX X1: **IPT Simulation Issues Matrix - Original Compilation**

Taxi: Immediately apply brakes, ROA wait for take-off command, GND crew power down, safe ROA, tow.

Take-off, Enroute, Landing:

(1) ROC and ATC communicate immediately.

(2) ATC advise other traffic, provide clearance in area of ROA decent.

(3) Broadcast "Emergency' code.

(4) Alert emergency services to clear estimated impact zone if time permits.

APPENDIX X1: **IPT Simulation Issues Matrix - Original Compilation**

APPENDIX X1: **IPT Simulation Issues Matrix - Original Compilation**

Information will be received at the ROA from the AVCS.
Information will be received at the ROA from the AVCS.
Information will be acknowledged at the AVCS from the ROA.
Information will be acknowledged at the AVCS from the ROA.

APPENDIX X1: **IPT Simulation Issues Matrix - Original Compilation**

Receiver will respond upon receipt, verifying information received.
Receiver will respond upon receipt, verifying information received.
Receiver will respond upon receipt, verifying information received.
Acknowledgement of data transmission.
ROA's will be aware of the other aircraft in their vicinity and will follow guidance given by ATC to not disrupt the NAS.
Communication is established using normal means.
Terrestrial Link and Terrestrial/VHF Hybrid Link should not push the end to end delay over 250 milliseconds. However, ROA Relay probably would not meet the 250 millisecond requirement.

APPENDIX X1: **IPT Simulation Issues Matrix - Original Compilation**

Determine the operational impact threshold for BLOS voice communications latency between an ROA pilot and air traffic controller for operations above FL180.

Determine the latency threshold for BLOS operations that allow satisfactory manual flight control of a ROA for operations above FL180.

APPENDIX X1: IPT Simulation Issues Matrix - Original Compilation

(1) Aural alert and plan view display (2) Aural alert, plan view display, and avoidance maneuver guidance display.
(1) Pilot attempts to re-establish communication (2) If unable to re-establish reception, pilot commands ROA to squawk 7600 (3)Pilot contacts ATC by alternate means (4a)Return to Base (4b) Land at nearest Suitable Airport (4c) Continue on filed flight plan
same as above
same as above
(1) Pilot attempts to re-establish link (2) If unable to re-establish link, the ROA squawks 7700 (3a)Return to Base (3b) Land at nearest Suitable Airport (3c) Continue on filed flight plan

APPENDIX X1: IPT Simulation Issues Matrix - Original Compilation

same as above
(1) Pilot attempts to re-establish link (2) If unable to re-establish link, the ROA squawks 7700 (3a)Return to Base (3b) Land at nearest Suitable Airport (3c) Continue on filed flight plan
same as above
1) Pilot attempts to re-establish nominal ROA performance 2) If performance is not re-established, ROA is directed to execute best engine-out descent, given remaining ROA control authority, flight capability, etc 3) Descent path will follow shortest safe route to Nearest Suitable Airport
same as above
(1) Pilot attempts to re-establish appropriate ROA route (2) If unable to correct route, pilot commands ROA to Squawk 7700 (3) Pilot reports route deviation to ATC (1) Pilot attempts to re-establish appropriate ROA altitude (2) If unable to correct altitude, pilot commands ROA to Squawk 7700 (3) Pilot reports altitude deviation to ATC
(1) Pilot attempts to re-establish communication (2) If unable to re-establish reception, pilot commands ROA to squawk 7600 (3)Pilot contacts ATC by alternate means (4a)Return to Base (4b) Land at nearest Suitable Airport (4c) Continue on filed flight plan
same as above

same as above
(1) Pilot attempts to reestablish communications (2) ROA Squawks 7600 (3) Re-establish communications via alternative means (cell phone, transponder, etc.)
same as above
(1) Pilot attempts to re-establish link (2) If unable to re-establish link, the ROA squawks 7700 (3a)Return to Base (3b) Land at nearest Suitable Airport (3c) Continue on filed flight plan
same as above

APPENDIX X1: **IPT Simulation Issues Matrix - Original Compilation**

APPENDIX X1: IPT Simulation Issues Matrix - Original Compilation

Existing Procedures, etc.	Criteria	Test Method	Hazard	Root Cause
		Access 5 Simulation candidate		One or more failed ATC or ROC items Single string failure Lightening or environmental EMI
		Access 5 Simulation candidate		One or more failed ATC or ROC items Single string failure Lightening or environmental EMI
				outside source violating freq assignment inadvertently
				One or more failed ATC or ROC items Single string failure Lightening or environmental EMI
				One or more failed ATC or ROC items Single string failure Lightening or environmental EMI

APPENDIX X1: **IPT Simulation Issues Matrix - Original Compilation**

		Access 5 Simulation candidate		outside source violating freq assignment inadvertently
				(A) (No Suggestions) Issues (B) Solar Activity
		Access 5 Simulation candidate		Security violated Lightening or environmental EMI
				ROA design and materials inherent limitations Nature unpredictable / uncontrollable
				Human oversight/error Nature unpredictable / uncontrollable Sensor failure
				Software error, processor failure, damaged/ degraded memory or storage device
				Software error, processor failure, damaged/ degraded memory or storage device
				Software error, processor failure, damaged/ degraded memory or storage device

APPENDIX X1: **IPT Simulation Issues Matrix - Original Compilation**

				(A) Degraded, damaged actuators (B) Defective Controllers (C) Degraded or loss of power

APPENDIX X1: **IPT Simulation Issues Matrix - Original Compilation**

APPENDIX X1: IPT Simulation Issues Matrix - Original Compilation

Pilots in the aircraft are adjusting flight instruments regarding route, altitude, speed, etc.	Ensure when data is transmitted from the AVCS that the receipt is acknowledged by the ROA.	AVCS simulation	ROA not receiving AVCS information may cause operational and safety issues.	
Pilots in the aircraft are adjusting flight instruments regarding route, altitude, speed, etc.	Ensure when data is transmitted from the AVCS that the receipt is acknowledged by the ROA noting if LOS or BLOS to ensure both work properly.	AVCS simulation	ROA not receiving AVCS information may cause operational and safety issues.	
Pilots in the aircraft are adjusting flight instruments regarding route, altitude, speed, etc.	Ensure when data is transmitted from the ROA that the receipt is acknowledged by the AVCS.	AVCS simulation	AVCS not receiving ROA information may cause operational and safety issues.	
Pilots in the aircraft are adjusting flight instruments regarding route, altitude, speed, etc.	Ensure when data is transmitted from the ROA that the receipt is acknowledged by the AVCS noting if LOS or BLOS to ensure both work properly.	AVCS simulation	AVCS not receiving ROA information may cause operational and safety issues.	

APPENDIX X1: **IPT Simulation Issues Matrix - Original Compilation**

Aircraft pilots acknowledge instrumental information by adjusting altitude, speed, etc based on feedback from instruments.	Ensure there is no "cross talk" when transmissions are initiated.	AVCS simulation	operational/safety issues	
Aircraft pilots acknowledge instrumental information by adjusting altitude, speed, etc based on feedback from instruments.	Ensure the message received and the message transmitted are the same information.	AVCS simulation	operational/safety issues	
Aircraft pilots acknowledge instrumental information by adjusting altitude, speed, etc based on feedback from instruments.	Determine if the message is delivered within an acceptable timeframe.	AVCS simulation	operational/safety issues	
Aircraft pilots acknowledge instrumental information by adjusting altitude, speed, etc based on feedback from instruments.	Ensure data packets are in standardized format. If not, identify the packet source so research can be completed.	AVCS simulation	operational/safety issues	
Various regulations regarding flight are followed by pilots and ATC to ensure all aircraft navigate the NAS without interference.	Ensure no other aircraft have to make adjustments in order to accommodate the ROA.	AVCS simulation	operational/safety issues	
Pilots and ATC communicate via voice and data transfers. The same will be for ROA's.	Ensure "normal" communication methods are used for ROA's.	AVCS simulation	operational/safety issues	
250 milliseconds is the current standard	Monitor the amount of time between the pilot PTT event and communications initialization. Successes are less than 250 milliseconds.	Pilot and controller in-the-loop simulation.	Non-standard delays are expected to adversely affect operations and safety.	

APPENDIX X1: **IPT Simulation Issues Matrix - Original Compilation**

Definition of C3 voice communications latency requirement.	Current communications latency is very small and does not impact communications operations or safety.	Examine various latencies to determine the effec(s) on communications. A threshold will be defined, above which, the communications delay will be unacceptably large and, below which, the delay will be acceptable.	Pilot and controller in-the-loop ACS simulation. Multiple aircraft and pilots in realistic scenarios appropriate for the Step. Independent variables: Voice latency with multiple levels. Dependent Variables: Pilot observations, controller observations, effects on traffic flow, effects on communications (e.g., blocked transmissions, requests for repeats)	Non-standard delays in communications are expected to adversely affect operations and safety: First, delays may increase the total amount of time devoted to complete required communications tasks. Second, delays may increase the rate of deviations from the standard phraseology and procedures (e.g., partial or missing read backs) if words or pilot responses are omitted to shorten the dialogues. Third, delays may result in more simultaneous transmissions or retransmissions if the expected time window for a
Definition of C3 data communications latency requirement for manual flight control. Description of flying qualities for manual control of ROA as a function of C3 data latency.	Current latency is very small and does not impact manual control or safety.	Examine various latencies to determine the effect on the pilot-vehicle control loop. A threshold or thresholds will be determined above which pilot ability to send flight control commands to the aircraft and receive feedback, will not allow for satisfactory aircraft control, and below which, satisfactory control can be achieved.	Pilot in-the-loop ACS simulation. One or more manually-flown aircraft may be evaluated appropriate for Step 1 and Step 2. Independent variables: Data latency with multiple levels. Dependent Variables: Aircraft-pilot interactions , pilot-involved oscillations, and non-oscillatory events.	Excessive data communication latency shall not interfere with pilot ability to manually control the ROA. The pilot shall have timely information and control capability so that pilot-ROA interactions are not adverse, unfavorable, nor compromise safety. Unfavorable interactions include anomalous aircraft-pilot interactions (closed loop), pilot-involved oscillations (categories I, II or III), and non-oscillatory events (e.g., divergence).
(1) Diversion to nearest suitable. (2) Return to origin. (3) Continuance to destination				

APPENDIX X1: **IPT Simulation Issues Matrix - Original Compilation**

(1) Diversion to nearest suitable. (2) Return to origin. (3) Continuance to destination				
				Software error, processor failure, damaged/ degraded memory or storage device
				same as above
				same as above
(1) Pilot attempts to reestablish communications (2) ROA Squawks 7600 (3) Continue attempts to e-establish communications		Access 5 Simulation candidate		One or more failed ATC or ROC items Single string failure Lightening or environmental EMI

APPENDIX X1: **IPT Simulation Issues Matrix - Original Compilation**

same as above		Access 5 Simulation candidate		One or more failed ATC or ROC items Single string failure Lightening or environmental EMI
(1) Pilot attempts to reestablish communications (2) ROA Squawks 7600 (3) Continue attempts to e-establish communications				Software error, processor failure, damaged/ degraded memory or storage device
same as above				same as above
				Software error, processor failure, damaged/ degraded memory or storage device
				same as above

APPENDIX X1: IPT Simulation Issues Matrix - Original Compilation

				same as above
(1) Pilot attempts to reestablish communications (2) ROA Squawks 7600 (3) Continue attempts to e-establish communications				
same as above				

APPENDIX X1: **IPT Simulation Issues Matrix - Original Compilation**

APPENDIX X2: IPT Simulation Issues Matrix - Candidate Contingencies and Related Issues

IPT	Functional Category	Issue	Related Issues	AOS Candidates	First AOS (July '05)	First Contingency Management AOS (September '05)
CM	**A) Degraded Ability to Follow ATC Commands**	1. Intermittent Reception from ATC	**CM B7, C3 L1, C3/HSI A1, C3/HSI B1**	√		√
		2. No Reception from ATC	**CM B7, C3 L1, C3/HSI A1, C3/HSI B1, SIM B2, SIM A1, SIM A3, POL A1, POL A3, POL B1, POL B2**	√		√
		3. False Reception from ATC	**CM B7, CM B3, C3 L1, C3/HSI A1, C3/HSI B1**	√		
		4. Intermittent Reception from ROC		√		
		5. No Reception from ROC	**CM A7, CM B5**	√		
		6. False Reception from ROC	**CM A9, CM B3**	√		
		7. Loss of ROC to ROA C2	**CM A5, CM B5**	√		
		8. Loss of ROA to ROC C2	**CM B4**	√		
		9. False ROC to ROA C2	**CM B5**	√		
	B) Unable to Follow Mission Route Plan	1. Atmospheric conditions	**POL D1, POL D2**	√		
		2. Environmental obstacles		√		
		3. Erroneous Data Transmission	**CM A3, CM A6, C3 H1**	√		√
		4. ROA Control Intermittent or Failed	**CM A8, C3 A1, C3 B1, C3 C1, C3 D1, C3 E1, SIM A1, SIM A2, SIM A3, SIM C1, SIM C2, POL A1, POL A2, POL A3, POL C1, POL C2**	√		√
		5. ROC Control Intermittent or Failed	**CM A5, CM A6, CM A7, CM A9**			
		6. Procedural				
		7. Lack of ATC clearance to continue mission	**CM A1, CM A2, CM A3, SIM B1, SIM B2, POL A1,**	√		
	C) Inability to Sustain Flight	1. Power Plant	**CM D2, SIM C3, SIM C4, POL E1**	√		√
		2. Vehicle Flight Control	**CM D2, POL E3**	√		
	D) Degradation of Situational Awareness due to Loss of Non-Flight Essential System	1. Collision Avoidance	**CCA A1, CCA A2, CCA A3, HSI B1, POL E6**	√		
		2. Aircraft State	**CM C1, CM C2, CCA B1, SIM C3, SIM C4, POL E1**	√		
		3. Safety Systems	**CCA A1**			

APPENDIX X2: IPT Simulation Issues Matrix - Candidate Contingencies and Related Issues

CCA	**A) Situational Awareness System failure**	1. Intruder systems, ROAS sensor system, or display fails and ROAS pilot unable to maintain situational awareness of intruder aircraft.	**CM D1, CM D3, CM B3, POL E3**			
		2. Intermittent reception/ processing of intruder data causes system to fail to track intruder.	**CM D1, CM B3**			
		3. Human system interface fails to provide adequate situational awareness to ROAS pilot.	**CM D1, CM B3**			
	B) ROAs interaction with normally-equipped (i.e., TCAS) aircraft in the NAS	1. ROAS has reduced climb capability compared with other traffic.	**CM D3, CM C2**	√	√	√
		2. ROAS uses an alternative collision avoidance logic that results in longer look-ahead time than other traffic. Maneuvers before traffic is warned of a conflict and before ATC expects action.	**CM D1, CM D3, POL E6**	√		
		3. Excessive link delays cause the ROAS to not respond in sufficient time to resolve a potential collision.	**CM B3, CM B4, CM D3**	√		
	C) ROAs Pilot Behavior	1. ROAS pilot fails to detect intruder aircraft -- ROAS pilot fails to scan display.				
		2. ROAS pilot fails to track intruder -- cognitive skills.				
		3. ROAS pilot fails to identify intruder as a threat -- unrecognized collision course.				
		4. ROAS pilot does not maneuver, maneuvers incorrectly, or maneuvers late -- selected maneuver does not solve conflict.				
		5. ROAS pilot does not maneuver, maneuvers incorrectly, or maneuvers late -- ROAS performance.				
	C) ROAS encounter with other 'low performance' aircraft	1. Two aircraft that cannot climb at TCAS-like rates are on a collision geometry .	**CM D1, CCA B1**	√		

APPENDIX X2: IPT Simulation Issues Matrix - Candidate Contingencies and Related Issues

C3	**A) The C2 communicationsss System shall use the uplink to transfer information from the AVCS to the ROA.**	1. The AVCS must be able to provide information to the ROA regarding flight instructions.	**C3 B1, C3 E1, CM B5, POL E3**	√	√	√
	B) The C2 link shall provide LOS and/or BLOS uplink communicationsss as needed between the ROA and AVCS.	1. The ROA will receive information from the AVCS regardless of its proximity to the AVCS.	**C3 A1, C3 E1, CM B5, POL E3**	√		
	C) The C2 communicationsss System shall use the downlink to transfer information from the ROA to the AVCS.	1. The ROA must be able to provide information to the AVCS regarding status information.	**C3 D1, C3 E1, CM B5**	√	√	
	D) The C2 link shall provide LOS and/or BLOS downlink communicationsss as needed between the ROA and AVCS.	1. The AVCS will receive information from the ROA regardless of its proximity to the ROA.	**C3 C1, C3 E1, CM B5**	√		
	E) The C2 communicationsss System shall coordinate the uplink and downlink operations to provide orderly message transfer.	1. THSI coordination will ensure that both uplink and downlink communicationsss are conducted in a timely manner.	**C3 A1, C3 B1, C3 C1, C3 D1, C3 G1**	√	√	√
	F) The C2 communicationsss System shall maintain message intelligibility during both uplink and downlink operations.	1. THSI will ensure that message transmission is understood by both parties.	**C3 A1, C3 B1, C3 C1, C3 D1**	√	√	
	G) The C2 communicationsss System shall provide a means to limit message delivery delays.	1. Messages must be delivered in a timely manner in order to be useful.	**C3 A1, C3 B1, C3 C1, C3 D1, C3 E1**	√		
	H) The C2 communicationsss System shall provide procedures for data transmission.	1. Data transmission parameters include frequency, data rate, modulation/coding, antenna usage, transmit power, etc.	**CM B3**	√		
	I) Shall not generate harmful interference to other NAS systems	1. The HALE ROA ATC communicationss system shall not generate harmful interference to other NAS systems such as navigation, landing, and surveillance.		√		
	J) Shall operate under the existing RFI environments	1. The HALE ROA ATC communicationss system shall operate under the existing RFI environments.		√		
	K) End-to-End Voice communicationsss Delay	1. The HALE ROA ATC A/G communicationss System shall initiate ATC A/G communicationsss within 250 milliseconds of a pilot PTT event.	**CM A1, CM A2, CM A3**	√		
	L) communicationss latencies with ATC	1. Consistent/variable latency	**CM A1, CM A2, CM A3, C3/HSI A1, C3/HSI B1**	√	√	√

APPENDIX X2: IPT Simulation Issues Matrix - Candidate Contingencies and Related Issues

C3/HSI	**A) HSI/C3-1: Pilot-ATC voice latency effects on operations (to be coordinated with C3)**	1. What are the operational impacts for BLOS voice communicationsss between an ROA pilot and air traffic controller for operations above FL180?	**CM A1, CM A2, CM A3, C3 L1, C3/HSI B1**	√	√	√
	B) HSI/C3-2. Pilot-ROA communicationsss latency effects on ROA manual flight control (BLOS)(to be coordinated with C3)	1. Can a ROA be flown manually BLOS? Will Access5 dictate that no ROA can be manually flown BLOS?	**CM A1, CM A2, CM A3, C3 L1, C3/HSI A1**	√		
HSI	**A) Degraded Ability to Control ROA**	1. What are the operational impacts of loss link between pilot and ROA?	**CM A8, CM B4, C3 A1, C3 B1, C3 C1, C3 D1, C3 E1, SIM A1, SIM A3**	√		√
	B) Collision Avoidance Criticality	1. Is Avoidance Maneuver Guidance Information necessary for satisfactory collision avoidance performance for operations above FL180?	**CM D1, CCA A1, CCA A2, CCA A3, POL E6**	√		
	C) Pilot Situational Awareness	1. Information requirements for efficient pilot situational awareness.	**CCA A1, CCA A3**			
SIM	**A) Multiple Contingencies**	1. Complete loss of ATC-Pilot communicationsss, and complete loss of command link.	**CM A8, CM B4, C3 A1, C3 B1, C3 C1, C3 D1, C3 E1, SIM B2, POL A1, POL B2, POL C2**	√		√
		2. Complete loss of ATC-Pilot communicationss, and temporary loss of command link.	**CM A8, CM B4, C3 A1, C3 B1, C3 C1, C3 D1, C3 E1, SIM B2, POL A2, POL B2, POL C1**	√		
		3. Temporary loss of ATC-Pilot communicationss, and complete loss of command link.	**CM A8, CM B4, C3 A1, C3 B1, C3 C1, C3 D1, C3 E1, SIM B1, POL A3, POL B1, POL C2**	√		
	B) Degraded Ability to Follow ATC Commands	1. Temporary loss of two-way communicationss between pilot and ATC	**CM A1, SIM A2, POL A2, POL B1**	√		√
		2. Complete loss of two-way communicationss between pilot and ATC	**CM A2, SIM A1, SIM A3, POL A1, POL A3, POL B2**	√		√
	C) Degraded Ability to Control ROA	1. ROA experiences temporary loss of command link.	**CM A8, CM B4, C3 A1, C3 B1, C3 C1, C3 D1, C3 E1, SIM A2, POL A2, POL C1**	√		√
		2. ROA experiences complete loss of command link.	**CM A8, CM B4, C3 A1, C3 B1, C3 C1, C3 D1, C3 E1, SIM A1, SIM A3, POL A1, POL A3, POL C2**	√		√
		3. ROA experiences temporary loss of engine performance.	**CM C1, CM D2, SIM C4, POL E1, POL E2**	√		√
		4. ROA experiences complete loss of engine performance.	**CM C1, CM D2, SIM C3, POL E1, POL E2**	√		√
	D) Degraded Ability to Follow Flight-Plan	1. Unintended route diversion		√		√
		2. Unintended altitude diversion		√		√

APPENDIX X2: IPT Simulation Issues Matrix - Candidate Contingencies and Related Issues

POLICY	**A) Multiple Contingencies**	1. Complete loss of ATC-Pilot communicationss, and complete loss of command link.	**CM A8, CM B4, C3 A1, C3 B1, C3 C1, C3 D1, C3 E1, SIM A1, POL B2, POL C2**	√	√	
		2. Complete loss of ATC-Pilot communicationss, and temporary loss of command link.	**CM A8, CM B4, C3 A1, C3 B1, C3 C1, C3 D1, C3 E1, SIM A2, SIM B2, POL C1**	√		
		3. Temporary loss of ATC-Pilot communicationss, and complete loss of command link.	**CM A8, CM B4, C3 A1, C3 B1, C3 C1, C3 D1, C3 E1, SIM A3, SIM B1, POL B1, POL C2**	√		
	B) communicationss Issues	1. Temporary loss of two-way communicationss between pilot and ATC.	**CM A1, SIM A2, SIM B1, POL A2**	√		√
		2. Complete loss of two-way communicationss between pilot and ATC.	**CM A2, SIM A1, SIM A3, SIM B2, POL A1, POL A3**	√		√
	C) Command/Status Link Issues	1. Temporary command/status link interruption	**CM A8, CM B4, C3 A1, C3 B1, C3 C1, C3 D1, C3 E1, SIM A2, SIM C1, POL A2**	√		√
		2. Complete loss of command/status link	**CM A8, CM B4, C3 A1, C3 B1, C3 C1, C3 D1, C3 E1, SIM A1, SIM A3, SIM C2, POL A1, POL A3**	√		√
	D) Weather Issues	1. Excessive turbulence	**CM B1**	√		
		2. Excessive icing	**CM B1**	√		
	E) On-Board System Issues	1. Power System Failures	**CM C1, CM C2, CM D2, CCA B1, SIM C3, SIM C4**	√	√	√
		2. Propulsion System failures	**CM C1, CM D2, SIM C3, SIM C4**	√		
		3. Flight Control System failures	**CCA A1, C3 A1, C3 B1, C3 C1**	√		
		4. Navigation Systems failures		√		
		5. Payload System failures		√		
		6. Cooperative Collision Avoidance Systems failures	**CM D1, CCA A1, CCA A2, CCA A3, CCA B2, HSI B1**	√		
		7. Mechanical or other systems failures		√		

APPENDIX X2: IPT Simulation Issues Matrix - Candidate Contingencies and Related Issues

AVCS Simulation Candidates
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APPENDIX X2: IPT Simulation Issues Matrix - Candidate Contingencies and Related Issues

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APPENDIX X2: **IPT Simulation Issues Matrix - Candidate Contingencies and Related Issues**

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APPENDIX X2: IPT Simulation Issues Matrix - Candidate Contingencies and Related Issues

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APPENDIX X3: IPT Simulation Issues Sorted by Function - (Highlighted Elements Addressed in First Contingency Management AOS)

	FUNCTION	ISSUES
Single Element Issues	Communications Issues	1. Intermittent Reception from ATC
		2. Complete loss of two-way communications between pilot and ATC.
		3. Temporary loss of two-way communications between pilot and ATC.
		4. False Reception from ATC
		5. Intermittent Reception from ROC
		6. No Reception from ROC
		7. False Reception from ROC
		8. Loss of ROC to ROA C2
		9. Loss of ROA to ROC C2
		10. False ROC to ROA C2
		11. Lack of ATC clearance to continue mission
		12. The HALE ROA ATC communications system shall not generate harmful interference to other NAS systems such as navigation, landing, and surveillance.
		13. The HALE ROA ATC communications system shall operate under the existing RFI environments.
		14. The HALE ROA ATC A/G communications system shall initiate ATC A/G communications within 250 milliseconds of a pilot PTT event.
		15. Constant/variable communications latencies
		16. THSI coordination will ensure that both uplink and downlink communications are conducted in a timely manner.
		17. What are the operational impacts for BLOS voice communications between an ROA pilot and air traffic controller for operations above FL180?
	Command/Status Link Issues	1. Intermittent ROA Control
		2. Complete loss of command/status link
		3. Temporary loss of command/status link
		4. Intermittent ROC Control
		5. Failed ROC Control
		6. Excessive link delays cause the ROAs to not respond in sufficient time to resolve a potential collision.
		7. The AVCS must be able to provide information to the ROA regarding flight instructions.
		8. The ROA will receive information from the AVCS regardless of its proximity to the AVCS.
		9. The ROA must be able to provide information to the AVCS regarding status information.
		10. The AVCS will receive information from the ROA regardless of its proximity to the ROA.

APPENDIX X3: IPT Simulation Issues Sorted by Function - (Highlighted Elements Addressed in First Contingency Management AOS)

	11. THSI will ensure that message transmission is understood by both parties.
	12. Messages must be delivered in a timely manner in order to be useful.
	13. Data transmission parameters include frequency, data rate, modulation/coding, antenna usage, transmit power, etc.
	14. Can a ROA be flown manually BLOS? Will Access5 dictate that no ROA can be manually flown BLOS?
	15. What are the operational impacts of loss link between pilot and ROA?
	16. Erroneous data transmission
Aircraft Performance Issues	1. Power Plant
	2. ROAs has reduced climb capability compared with other traffic
	3. ROAs experiences complete loss of engine performance.
	4. ROAs experiences temporary loss of engine performance.
	5. Aircraft begins to exit holding pattern without ATC command.
	6. Aircraft performs uncommaned flight plan deviation.
	7. Aircraft performs uncommaned altitude deviation.
	8. ROA experiences partial turbocharger failure causes loss of power.
	9. ROA's fuel expires
	10. ROAs cruise speed is slower than overtaking traffic.
	6. ROA pilot does not maneuver, maneuvers incorrectly, or maneuvers late -- ROAs performance
Aircraft System Issues	1. Cooperative Collision Avoidance systems failure
	2. Propulsion systems failure
	3. Safety systems failure
	4. ROA uses an alternative collision avoidance logic that results in longer look-ahead time than other traffic. Maneuvers before traffic is warned of a conflict and before ATC expects action.
	5. Intruder systems, ROAs sensor system, or display fails and ROAs pilot unable to maintain situational awareness of intruder aircraft.
	6. Intermittent reception/ processing of intruder data causes system to fail to track intruder.
	7. Human system interface fails to provide adequate situational awareness to ROAs pilot.
	8. GPS Navigation systems failure
	9. Payload systems failure
	10. Flight Control systems failure
Pilot Action Issues	1. ROA pilot fails to detect intruder aircraft -- ROAs pilot fails to scan display
	2. ROA pilot fails to track intruder -- cognitive skills

APPENDIX X3: IPT Simulation Issues Sorted by Function - (Highlighted Elements Addressed in First Contingency Management AOS)

		3. ROA pilot fails to identify intruder as a threat -- unrecognized collision course
		4. ROA pilot does not maneuver, maneuvers incorrectly, or maneuvers late -- selected maneuver does not solve conflict
	Environmental Issues	1. Atmospheric conditions
		2. Environmental obstacles
Multiple Element Issues		1. Complete loss of ATC-Pilot communications, and complete loss of command/status link.
		2. Complete loss of ATC-Pilot communications, and temporary loss of command/status link.
		3. Temporary loss of ATC-Pilot communications, and complete loss of command/status link.

APPENDIX X3: IPT Simulation Issues Sorted by Function - (Highlighted Elements Addressed in First Contingency Management AOS)

IPT
CM, C3, HSI, Policy
CM, CCA, C3, HSI Simulation, Policy
CM, C3, HSI, Simulation, Policy
CM, C3, HSI
CM
CM
CM
CM
CM
CM
CM
C3, HSI
C3
C3, HSI
CM, C3, HSI, Simulation, Policy
C3
CM, CCA, C3, HSI, Simulation, Policy
CM, C3, HSI, Policy
CM, CCA, C3, HSI, Simulation, Policy
CM, CCA, C3, HSI, Simulation, Policy
CM, C3
CM, C3
CM, CCA, C3, HSI, Simulation, Policy
CM, CCA, C3, HIS, Simulation, Policy
CM, CCA, C3, HIS, Simulation, Policy
CM, CCA, C3, HIS, Simulation, Policy
CM, CCA, C3, HIS, Simulation, Policy

APPENDIX X3: IPT Simulation Issues Sorted by Function - (Highlighted Elements Addressed in First Contingency Management AOS)

C3
CM, CCA, C3, HIS, Simulation, Policy
CCA
CM, CCA, C3, HIS, Simulation, Policy
CM, CCA, C3, HSI, Simulation, Policy
CM, CCA, C3, HIS, Simulation, Policy
CM, CCA, C3, Policy
CCA, Simulation
CM, CCA, C3, Simulation, Policy
CM, CCA, C3, Simulation, Policy
CM, CCA, C3, Simulation, Policy
CM, CCA, C3, Simulation, Policy
CM, CCA, C3, Simulation, Policy
CM, CCA, C3, Simulation, Policy
CM, CCA, C3, Simulation, Policy
CM, CCA, C3, Simulation, Policy
CCA, C3. Policy
CM, CCA, HSI, Policy
CM, Simulation, Policy
CM
CM, CCA, HSI, Policy
CCA, HSI, Simulation
CCA, HIS
CCA, HSI, Simulation
Simulation, Policy
Policy
CCA, C3, Policy
CCA, HSI, Simulation
CCA, HIS

APPENDIX X3: IPT Simulation Issues Sorted by Function -
(Highlighted Elements Addressed in First Contingency Management AOS)

CCA, HIS
CCA, HSI, Simulation
CM, Policy
CM
C3, Simulation, Policy
C3, Simulation, Policy
C3, Simulation, Policy