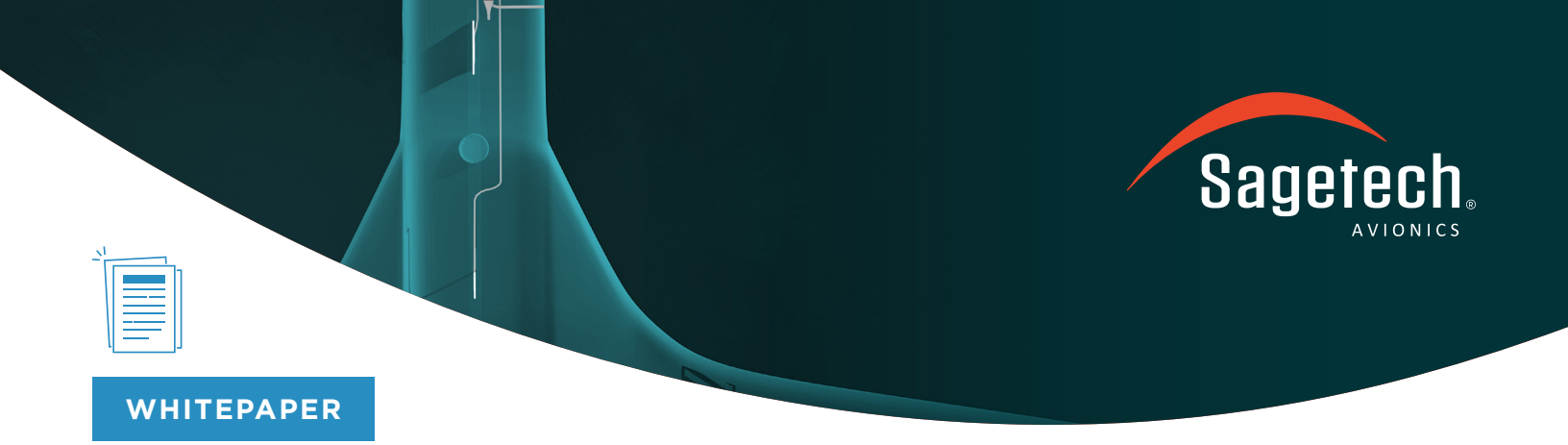

WHITEPAPER

How Test Sites Can Lead the U.S. in Robust, Safe, and Integrated Air Operations for Local, State, and Regional Emergency Response Operations with Sagetech Avionics DAA.

A Solution is Non-Negotiable

The use of remotely piloted aircraft (RPA) and uncrewed aircraft systems (UAS) in Local and State Emergency Response was once only available when the National Guard or DoD was activated to support a Disaster. However, obtaining necessary permissions for approved use of National Guard and Department of Defense (DoD) air assets is a lengthy process requiring a request from the Governor to the National Guard or from the Federal Emergency Management Agency (FEMA) to the Secretary of Defense (SecDef). The lead time for air support requests, mobilization, and deployment meant significantly increased risk for loss of life & delayed air asset support over an Emergency Response Event.

With the rise of available and increasingly affordable UAS in commercial markets, local communities have begun to not only procure and contract UAS for rapid deployment in times of need, but also utilize them for everyday operations such as critical infrastructure inspections, law enforcement operations, live-video feed, mapping & GIS, structural engineering inspections and many other applications. In the future, UAS will link communities together through air mobility, logistics and supply chain vehicles to deliver life-saving medicines and organs, and rescue pods for ambulances. To achieve this, municipal, county, and state agencies must establish standards as well as tactics, techniques, and procedures to facilitate their use. In addition, State Agencies, Test Sites, and the community of UAS and enabling technology providers must develop and offer reliable and sophisticated solutions that not only execute the mission, but also ensure Airspace Safety. Although each concept of operations requires a specifically tailored, detailed, and integrated plan, a technical standard may be established, ensuring maximum airspace safety as well as safeguards for non-participants on the ground. Test Sites can pave the way, developing various standardized processes, methods, procedures, and technology stacks such as:

- Identified & integrated technologies and aircraft well suited for Emergency Response Operations
- Coordinated and facilitated command & control (C2) protocols
- Assisted air traffic control operations
- Established & effective multi-spectrum air and ground communications networks
- Developed & creative airspace deconfliction methods
- Vetted detect and avoid (DAA) solutions
- Overseen and evaluated integrated crewed and uncrewed air operations

HOW TEST SITES CAN LEAD THE U.S. IN ROBUST, SAFE, AND INTEGRATED AIR OPERATIONS FOR LOCAL, STATE, AND REGIONAL EMERGENCY RESPONSE OPERATIONS WITH SAGETECH AVIONICS DAA.

Crippled without a Plan

In 2017, Hurricanes Maria, Harvey, and Irma devastated communities, infrastructure, and personal property. The FAA, as well as state and local governments, learned the value of UAS in facilitating recovery operations, reducing time for threat and damage assessments, as well as enhancing data collection and dissemination. In addition to UAS, crewed aviation (both fixed and rotary) is a critical element of air operations for mobility, search and rescue, general transportation, and logistics & supply delivery. After the devastating 7.0 magnitude earthquake that hit the island of Haiti, thousands of lives were lost, and international response agencies were forced to one usable airport. Due to the lack of radar and air traffic control, only one usable runway, and limited capacity, air operations were quickly overwhelmed. This led to the grounding of aircraft for over 20 hours until the DoD enabled Combat Control Teams (CCTs) to facilitate the airspace. Combined efforts of crewed and uncrewed aircraft, when properly coordinated, can significantly enhance the survivability and mobility of communities impacted by both manmade and natural disasters.

To date, there is limited guidance (tactical, operational, or strategic) on how to effectively coordinate and integrate crewed and uncrewed, civilian, and military aviation assets safely. Additionally, there are not well-established standards or requirements that ensure State, Local, and Federal Agencies can replicate safe air operations, procure effective and reliable enabling technologies, and apply effective methodologies for safe airspace integration consistently. Many communities that conduct tabletop exercises underestimate the complexity of air operations and do not fully understand proper prioritization of tasks that enable operations.

Although systems such as FirstNet (AT&T) are established to ensure communications for emergency responders, a communications plan for command and control of the complex air and ground operations at the local and/or state level does not exist. Congested airspace operations fall to the responsibility of the emergency operations center (EOC) or air operations center (AOC), but many communities do not have the knowledge, skills, or abilities to understand how to plan for, coordinate, or assign control authority to the proper delegate. Attempting to incorporate technologies that arrive 'on-station' only exasperates the complex airspace with little to no impactful result. The currently available technologies and the plethora of agencies, organizations, and companies executing Emergency Response Operations have not been integrated in an orderly, preemptive, and coordinated effort to enhance the resiliency and effectiveness of operations.

The Opportunity

Test Sites have an opportunity to establish a standard for crewed and uncrewed air integration & technologies for Emergency Response Operations nationally. To improve civil-military operations (CMO), Test Sites can bridge the gap between commercially available technologies and the Agencies that are seeking reliable and validated solutions to solve challenges and increase safety of the airspace. Test sites can replace the ad-hoc nature of Emergency Response with standard operating procedures (SOPs) for C2, crewed and uncrewed aircraft integration, DAA solutions, ADS-B data feeds, radar solutions, vehicle-to-vehicle links, remote ID, and air support solutions for First Response and natural disasters. These SOPs, including technology standards, should be agnostic to the type of event and scalable depending upon the severity and complexity of the situation. Additionally, each SOP should be hinged upon coordination and cooperation between each echelon of support and should standardize the aviation process for air mobility, air attack (counter fire), air evacuation, supply & logistics, utility inspection, search & rescue, DAA, and persistent surveillance/situational awareness.

Pulling from lessons learned and operating procedures such as J-CONOPS: *Air Mobility Coordination for Crisis Response, Oslo Guidelines, Haiti Flight Operations Coordination Center AAR, Synching Civil and Military Air Relief Efforts During a Catastrophic Crisis, Interagency Fire Unmanned Aircraft Systems Operations Guide, Unmanned aircraft systems for emergency management*: A guide for policy makers and practitioners, and others, the Test Sites have the opportunity to improve the response timeliness and rescue efforts for communities. By working with leaders and the agencies that are overseeing operations with enabling technologies such as the Sagetech Avionics ADS-B and DAA Solutions, proven and robust uncrewed aircraft, and non-cooperative traffic solutions, Test Sites can greatly enhance the way civil-military operations and local, state, and federal Emergency Response air operations.

DAA Enabled Airspace Deconfliction – The Solution

The act of performing airspace deconfliction has become increasingly difficult due to the growing abundance of non-cooperative aircraft including manned and unmanned platforms in airspace during emergency operations. Although notices to airmen (NOTAMs) and temporary flight restrictions (TFRs) are implemented and communicated, there will never be 100% certainty that compliance can be achieved. This is especially present during times where access to data, internet, news, and communications may be limited. Even with NOTAMs and TFRs in place, recent air operations have been grounded due to the sighting of an unmanned aircraft – non-cooperative non-participants. This is in part due to non-compliance or violations of TFRs, but also lack of proper, coordinated communication, siloed operations, and a missing cooperative/non-cooperative data feed to the Operations Centers. Up until present day, many of the deconfliction methods are completed via analog means (via continuous radio communications, a notebook and pen, and by applying a tactical method of lateral, altitude, and timing deconfliction method.

"With the Haitian air traffic control out of service, Air Force Special Operations Command (AFSOC) sent a team of Combat Controllers (CCT) the next day (13 Jan) to help control terminal air traffic. With handheld radios and working from a card table in the middle of the airfield they provided take off and landing clearance from the Port-au-Prince airport. They had no control over who was authorized to come in, when, and how long they would be allowed to stay on the ground. There was no system of prioritization or even knowledge of what the aircraft had on it, only a call sign. This only added to the bottleneck as CCT tried to fit as many aircraft as possible on the ramp. From the air commando's perspective maximizing parking spots on the ground was what it was all about."

At times, AIRBOSS and the individual entities (CCT or Joint Terminal Attack Controllers – JTACs) deconflicting specific areas of operations such as airports, runways, rescue operations sites must be able to quickly clear airspace of airborne platforms for air to surface approaches. Currently, this is accomplished with limited access to mobile radars for approach and proper, coordinated prioritization aided by Android Team Awareness Kit (ATAK). As more and more UAS enter the airspace, it will become increasingly important that they are equipped with ADS-B in and out or at a minimum, ADS-B receivers, and onboard DAA for collision avoidance. Once equipped with these solutions, the risk of air-to-air conflict will be greatly diminished, especially in congested air traffic areas such as hospitals and healthcare centers, air transit corridors, search and rescue sectors, and airfields.

The integration of new technologies such as the Sagetech Avionics ADS-B Transponders & DAA Solutions in a complex airspace environment becomes a force multiplier for airspace safety. By instituting a robust network of cooperative and non-cooperative (but linked) UAS, the AIRBOSS, EOC, and AOC are given a more conclusive understanding of the airspace, enabling more sophisticated and autonomous means of deconfliction. This greatly reduces the workload by overseers of the airspace.

Sagetech Avionics Technical Overview

Sagetech Avionics, an SBA-certified HUBzone small business, established the market for robust, low Size, Weight, and Power (SWaP) transponders for military and civil applications, and is now focused on developing DAA capabilities with similarly low SWaP. Sagetech Avionics is participating in consensus led industry committees such as RTCA SC-228 to develop the pertinent standard that will guide our development of DAA technology.

Sagetech Avionics intends to certify very low SWaP DAA solutions to enable UAS, UAM aircraft and AAM aircraft to safely integrate into the National Airspace System (NAS).

Compatible Solutions for Different Platforms and Operations

UAVs will be incorporated into a variety of missions. In many cases, the mission may involve having the aircraft operate relatively independently. In others, the UAV may be operating in close proximity with other aircraft, crewed and uncrewed in a cooperative fashion. Emergency response operations are a prime example of a mission where teaming is important for aircraft operations. The required Detect and Avoid behaviors need to be tailored to support these different scenarios as well taking into account the capabilities of the aircraft flying the mission. It is important to note that the need to support different DAA algorithms should not require different avionic solutions. Ideally the host avionics should remain the same and only require a simple update of the software and reference data to support the required mission. This is the approach that Sagetech is taking with its DAA Computer architecture. Equally importantly, Sagetech is partnering with a variety of test ranges and industry partners to test these algorithms and related CONOPS in real world scenarios. Following is an overview of the various DAA algorithms that are being developed and tested by the industry.

For larger (great than 55 pounds total weight) crewed and uncrewed UAS, the ACAS Xu (fixed wing) or ACAS Xr (rotary wing)-based DAA system will consist of a small Mode A/C/S transponder with ADS-B In and Out, vehicle-to-vehicle link (ACAS Xr only), a small Mode A/C/S omni directional interrogator for validating cooperative tracks and tracking Mode C equipped aircraft, a small commercial-off-the-shelf (COTS) air-to-air radar system and/or feed from ground-based radar surveillance system for detecting uncooperative targets, a track fusion module, a threat resolution module using ACAS Xu datasets, along with appropriate C2 links for providing traffic and resolution data to either the pilot display (crewed aircraft) or the Ground Control Station (GCS) display software (uncrewed aircraft). In addition to sending validated and correlated traffic information stream and DAA alerts and proscribed maneuvers to the GCS, the proscribed maneuvers may also be sent to a COTS autopilot to enable automatic evasive maneuvers to validate DAA automation performance, human machine interface, failure conditions and procedures. ACAS sXu-based DAA will incorporate a dual link receiver to enable coordinated avoidance maneuvers with small UAS, and a vehicle-to-vehicle link which will be standardized for small UAS and AAM vehicles, increasing the percentage of cooperative traffic without degrading the utilization of current ADS-B spectra. Sagetech Avionics is an active member of standards bodies such as IEEE and ASTM that are working on this emerging standard.

The ACAS Xu-based DAA CONOP will determine the feasibility of the novel approach using omni directional interrogation to validate ADS-B tracks and track Mode C aircraft while modulating output power and interrogation procedures to minimize 1090 MHz spectrum use. An omni-directional interrogator significantly reduces the size of the required antenna and reduces the components and complexity of the active surveillance circuits. Spectrum congestion issues can be eliminated through optimizing the use of all-call interrogations, lower power interrogations, modified interrogation sequences, or some combination of these approaches. The result will be a very small DAA system, capable of enabling aircraft as small as small Group 3 UAS to successfully detect and avoid other manned and unmanned airborne traffic without causing undue spectrum congestion issues on surveillance frequencies.

For smaller UAS, the ACAS sXu-based DAA system will employ passive ADS-B sensors, integrate remote ID, dual link receiver, a vehicle-to-vehicle link, and ground- or aircraft-based non-cooperative sensors to provide full detect and avoid capability optimized for size, weight, power and cost (SWaP-C) without overloading current safety-critical spectra. Sagetech will demonstrate and validate the performance, interoperability and effectiveness of DAA systems by conducting flight tests at a UAS Test Site. The DAA systems' performance and failure conditions will be demonstrated using simulation and analytic methods. These DAA systems, once enabled and scaled, enable safe airspace integration and deconfliction of UAS in the NAS.

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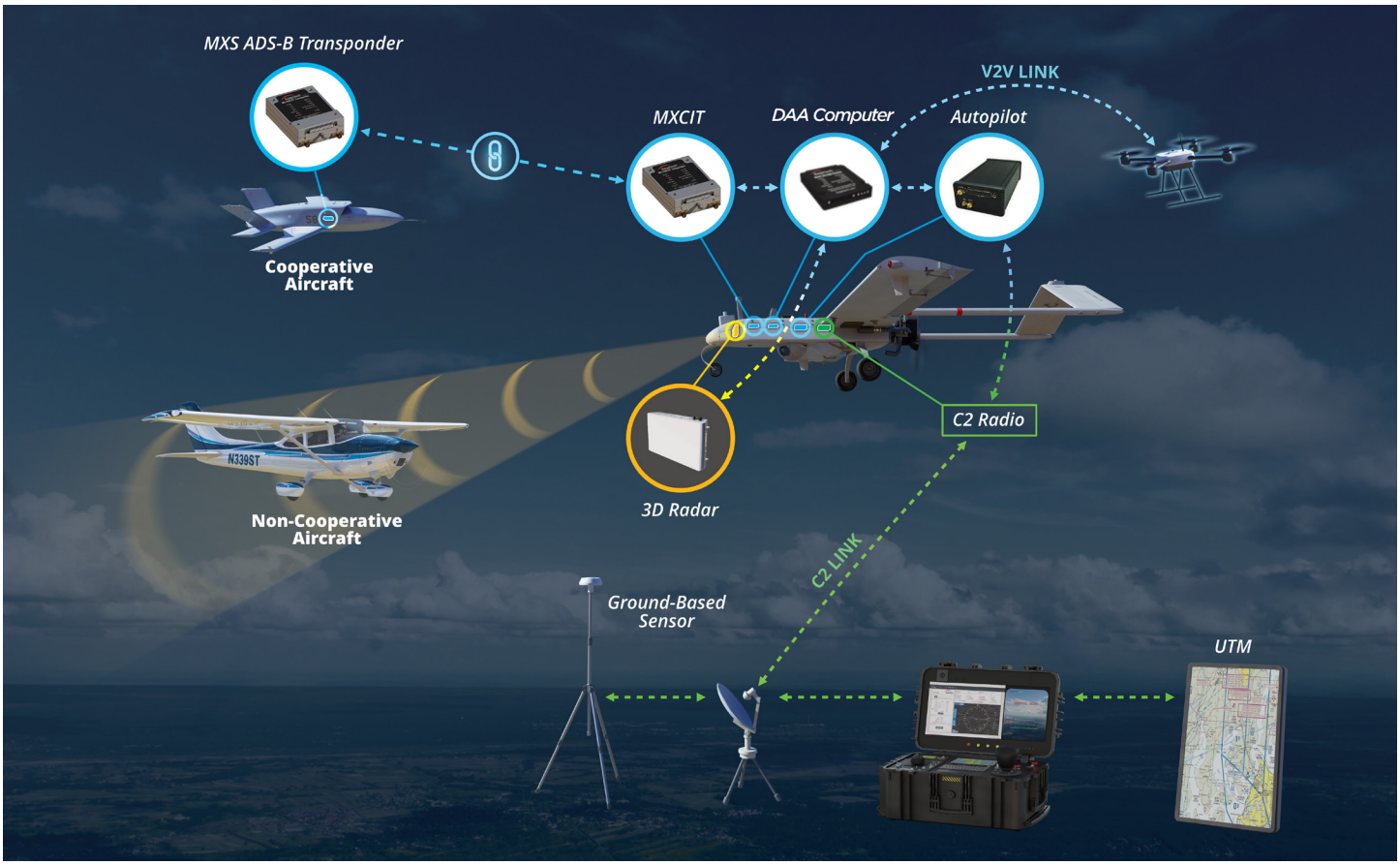
Specialty Systems

Sagetech and Israeli partner Ciconia LTD have been awarded a two-year grant by the Bi-national Industrial Research and Development (BIRD) Foundation, sponsored by the Department of Homeland Security, to develop a cooperative conflict management and collision avoidance system (C&CAS). This system is similar to ACAS sXu, but addresses a few specific issues relevant to Emergency Response Operations. C&CAS provides similar levels of safety to ACAS, measured by the probability of a near mid-air collision (PNMAC), with a low rate of false alarms, but enables closer flight paths between aircraft. The system also allows the On-Scene Coordinator to dynamically manage the prioritization of aircraft based on mission criticality, a capability specifically missing from FAA ACAS logic. For example, an uncrewed aircraft on a critical surveillance run could be prioritized over a crewed aircraft returning to land, reducing mission disruption while maintaining airspace safety.

This project will last throughout 2022 and 2023, during which time, test flights can be completed to help inform CONOP / SOP development.



To learn more about Sagetech's Detect and Avoid solutions, contact a DAA expert today.

About the Author:

Wes Shover, is Director of Sales and Channels for Sagetech Avionics and is a United States Veteran, previously serving as a Joint Terminal Attack Controller for the U.S. Air Force.

About Sagetech Avionics:

Sagetech is an aerospace technology company, empowering safe flight with the world's most reliable UAV transponders. Experience serving military and civil duty on most small to medium UAVs, Sagetech solutions are mission-proven and offer decades of program experience, certifications, and millions of flight hours to deliver maximum value over the life of an uncrewed platform. Today Sagetech is expanding its technology platform to create comprehensive situational awareness systems, such as detect and avoid solutions for uncrewed aircraft as well as collision avoidance for crewed and optionally crewed rotorcraft. Sagetech works in concert with its extensive ecosystem of OEM customers, technology partners, and resellers to ensure aircraft fly safer with Sagetech on board.

Sagetech® AVIONICS

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