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THE UNDER SECRETARY OF DEFENSE
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ACQUISITION,
TECHNOLOGY,
AND LOGISTICS

JUL 03 2014

The Honorable Carl Levin
Chairman
Committee on Armed Services
United States Senate
Washington, DC 20510

Dear Mr. Chairman:

Pursuant to section 1087(a) of the National Defense Authorization Act for Fiscal Year 2014 (Public Law 113-66), the enclosed report addresses the Department of Defense, Department of Transportation, Federal Aviation Administration, and National Aeronautics and Space Administration joint progress in unmanned aircraft system collaboration, demonstrations, and data sharing. Identical letters have been sent to the other appropriate congressional committees.

Sincerely,

Frank Kendall

Enclosure:
As stated

cc:
The Honorable James M. Inhofe
Ranking Member

Report to Congress on

Unmanned Aircraft Systems Collaboration, Demonstration, and Data Sharing

June 2014

Office of the Under Secretary of Defense
for Acquisition, Technology, and Logistics

The estimated cost of this report or study for the Department of Defense is approximately $8,380 for the 2014 Fiscal Year. This includes $5,700 in expenses and $2,690 in DoD labor.
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Reporting Requirement

Section 1087(a) of the National Defense Authorization Act (NDAA) for Fiscal Year 2014, Public Law 113-66, requires the Department of Defense (DoD), Department of Transportation (DOT), Federal Aviation Administration (FAA), and National Aeronautics and Space Administration (NASA) to report on collaboration, demonstration, and sharing of data relating to Unmanned Aircraft Systems (UAS):

(a) REPORT ON COLLABORATION, DEMONSTRATION, AND USE CASES AND DATA SHARING.—Not later than 180 days after the date of the enactment of this Act, the Secretary of Defense, the Secretary of Transportation, the Administrator of the Federal Aviation Administration, and the Administrator of the National Aeronautics and Space Administration, on behalf of the UAS Executive Committee, shall submit jointly to the appropriate congressional committees a report setting forth the following:

> *(1) The collaboration, demonstrations, and initial fielding of unmanned aircraft systems at test sites within and outside of restricted airspace.*
>
> *(2) The progress being made to develop public and civil sense-and-avoid and command-and-control technology.*
>
> *(3) An assessment on the sharing of operational, programmatic, and research data relating to unmanned aircraft systems operations by the Federal Aviation Administration, the Department of Defense, and the National Aeronautics and Space Administration to help the Federal Aviation Administration establish civil unmanned aircraft systems certification standards, pilot certification and licensing, and air traffic control procedures, including identifying the locations selected to collect, analyze, and store the data.*

This report was developed by the UAS Executive Committee agencies and coordinated within DoD, DOT, FAA, NASA, and DHS.

Background

In Section 1036 of the Duncan Hunter NDAA for FY 2009, Public Law 110-417, dated October 14, 2008, Congress recommended that DoD and FAA form an Executive Committee (ExCom) to act as a focal point for resolution of issues on matters of policy and procedures relating to UAS access to the National Airspace System (NAS). The sense of Congress was that progress has been lagging in the integration of UAS into the NAS for operational training, operational support to the Combatant Commanders, and support to domestic authorities in emergencies and natural disasters.

In response to the FY 2009 NDAA language, the Deputy Secretary of Defense and the Deputy Secretary of Transportation agreed to stand up the UAS ExCom and expanded its

membership to include NASA and the Department of Homeland Security (DHS) to more broadly capture other federal agencies' efforts and equities related to integration of UAS into the NAS. The mission of the UAS ExCom is "to enable increased and ultimately routine access of Federal UAS engaged in public aircraft operations into the NAS to support operational, training, development and research requirements of the FAA, DoD, DHS and NASA."

The "National Airspace System Access Plan for Federal Public Unmanned Aircraft Systems," Attachment 1 to the "DoD Final Report to Congress on Access to National Airspace for Unmanned Aircraft Systems" of October 2010, outlined the high level goals that the UAS ExCom partners needed to work towards to incrementally increase UAS Access to the NAS:

> *"Public operators of UAS have a goal to have appropriately equipped UAS gain routine access to the NAS in support of domestic operations, exercises, training, and testing. The FAA's goal is to ensure all UAS operations are conducted safely, present no threat to the general public, and do no harm to other users of the NAS. To reach these collective goals, the DoD, FAA, DHS, NASA, and aviation standards development organizations are collaborating in an effort to incrementally address the range of challenges confronting UAS airspace integration."*

UAS technology development was identified in the report as a key item in meeting the mid- and far-term requirements. Advancements in detect-and-avoid technology (DAA)[1], also known as sense-and-avoid, to include sensors, algorithms, and the integration of the sensors, displays, and Next Generation Air Transportation System (NextGen) technology are some of the major items required for DoD, NASA, and DHS UAS to meet their mission needs.

To effectively employ UAS in the NAS, a means such as a DAA system to ensure safe separation from other aircraft must be developed and policies must be in place to enable its use. DoD is investing significant resources in the development of DAA technology to enable enhanced UAS access to national and international airspace for DoD. The maturation of these systems may facilitate development of systems to support NASA and DHS mission needs as well as inform the FAA regarding policy development for public and civil applications.

Collaboration Activity and Demonstrations

UAS Technical Standards

The UAS ExCom agencies have been actively involved with the FAA's advisory committee led by RTCA, Inc., Special Committee 228 (SC-228), and industry in the development of DAA Minimum Operational Performance Standards (MOPS), which are critical

[1] The ICAO Air Navigation Commission, in November 2011, amended Annex 2 to the Chicago Convention to include "Detect-and-Avoid (DAA)" as the capability to see, sense, or detect conflicting traffic or other hazards and take the appropriate action. DOD, FAA and NASA use the term "Detect-and-Avoid" to refer only to the capability to see, sense, or detect conflicting traffic and take appropriate action. This use makes it equivalent to "Sense-and-Avoid" as used in previous Congressional reports. DAA programs focused on hazards other than conflicting traffic, if needed, will be addressed separately. Established development programs that include "sense-and-avoid" in in their name will continue to be used.

to the development and certification of DAA systems. SC-228 is also developing MOPS for command and control (C2) Data links. DoD, FAA, and NASA are providing committee leadership, research and development (R&D) data, lessons learned, and expertise to support the planning and development of the MOPS.

Alongside the work being done by SC-228, DoD with its ExCom partners hosted a multi-agency workshop in an effort to develop a quantifiable standard for "well clear" for UAS. The Federal Aviation Regulations require that pilots remain "well clear" of other aircraft when flying in the NAS, and recent DoD activities have identified defining "well clear" as the most urgent DAA research need. A quantitative definition of "well clear" is needed to design a UAS self-separation system to maintain "well clear" from other aircraft and provide a means to evaluate system performance. The RTCA SC-228 committee also considers defining "well clear" as an urgent priority in producing DAA MOPS. UAS ExCom partners are evaluating three alternative definitions for "well clear" against a standard set of operational acceptability metrics. The goal of this plan is to produce objective data in order to select a single "well clear" candidate definition. A quantitative definition of "well clear" is expected to be presented for SC-228 consideration in FY 2014.

UAS Operating Procedures

DoD is developing, testing, and evaluating standardized DoD UAS operating procedures. The goal is to standardize DoD UAS procedures such that safety and predictability of operations are ensured in case of a contingency (e.g., lost link). The DoD UAS-Airspace Integration (AI) Concept of Operations Joint Test, involving subject matter experts from NASA and DHS for concept development and test support from the FAA, is aimed at validating standard procedures for DoD UAS access to the NAS and served as a follow-on to 2012's DoD UAS AI Quick Reaction Test.

The first series of field tests were completed in FY 2013 and consisted of a mix of simulated entities and emulated systems with human-in-the-loop to create a virtual environment similar to the conditions under which UAS operate in the NAS. The modeling and simulation (M&S) tested a set of standard procedures to facilitate safe operations of UAS experiencing in-flight contingencies involving loss of control link, loss of two-way radio communications, and loss of DAA capability. The M&S test and accompanying live flight testing at three DoD airfields indicate that appropriately developed procedures will help DoD UAS safely integrate into the NAS with an acceptable impact to air traffic control workload and other NAS users.

A second series of field tests will be conducted in FY 2014 and will consist of an M&S event as well as a human-in-the-loop simulation conducted at the FAA's William J. Hughes Technical Center, followed by three live flight events. DoD is working closely with the FAA to ensure the procedures being developed for DoD UAS are compatible with existing Air Traffic Management practices and are sufficiently documented to be able to inform civil standards.

NASA conducted validation testing of processes and procedures for small UAS night operations developed by the UAS ExCom's Small UAS Working Group (WG). NASA has

sponsored additional testing of UAS night operations that is currently underway. Knowledge gained from the initial testing has been used by NASA and other public agencies to develop memoranda of agreement with the FAA for conducting safe night operations. The data from past and present testing will be used by the FAA for operations for small UAS operated within visual line of sight.

The UAS ExCom agencies with other public agencies and industry developed processes and procedures to safely demonstrate small UAS operations in remote areas of the Arctic, in domestic and international airspace on and off the coast of Alaska. This activity was done in support of the FAA Arctic Small UAS Integration Plan as directed by the FAA Modernization and Reform Act of 2012. In the summer of 2013, three arctic operations with multiple small UAS were successfully conducted by NASA, U.S. Coast Guard, National Oceanic and Atmospheric Administration, and Conoco-Phillips. All operations were conducted safely, met 100 percent of their test objectives and accomplished some notable "firsts," including:

- First coastal UAS ingress/egress route established.
- First non-DoD ground-based DAA technology to enable operations beyond line-of-sight.
- First civil certifications for two small UAS (Scan Eagle, Puma.)

The Arctic UAS demonstrations will be repeated in the summer of 2014 and should yield a reproducible blueprint for safe and routine integration of civil UAS into Arctic airspace.

DHS, with DoD support, is conducting a Robotic Aircraft for Public Safety (RAPS) program to flight test and evaluate the operational suitability and safety of a variety of small UAS-airborne sensor combinations. The RAPS assessment uses a wide variety of simulated but realistic operational scenarios that focus on situations in which human lives are in imminent danger. The purpose of this program is to produce knowledge and a database resource consisting of guidelines for small UAS for adoption by the law enforcement and public safety communities. The program will produce "Consumer Reports" style products to help public agencies, such as police and fire departments, determine which Small UAS platforms will best meet their operational needs.

UAS Research & Development

DoD, NASA, and the FAA are working together to address cross-cutting DAA initiatives. The intent is to gain insight into efforts that align the agencies priorities and identify sound technical approaches to address DAA research needs. As an example, FAA requested and DoD provided 26 UAS pilots to support a Human-in-the-Loop simulation to investigate minimum necessary information elements to perform a collision avoidance maneuver in various operational scenarios at the FAA's William J. Hughes Technical Center. Through this collaborative process, the UAS ExCom agencies are coordinating with the science and research community to identify common research needs and leverage research efforts across multiple organizations. This joint effort is sponsoring workshops and meetings to assess and prioritize research needs.

DoD has a number of on-going efforts that focus on the technological challenges to develop and field UAS DAA systems that will facilitate routine access to the NAS. DoD, FAA, NASA, DHS, and other Federal Agencies identified the requirements and initial goals for UAS integration in the 2012 "NextGen UAS Research, Development, and Demonstration Roadmap" developed by the NextGen Joint Planning and Development Office (JPDO). While many of the challenges and goals in the roadmap are intended to increase NAS access for civil operators, DoD is currently pursuing technology and process improvements that will support progress towards 10 of the identified 23 initial goals.

DoD's R&D efforts are primarily focused on addressing the challenges in the "Airspace Operations" category in the JPDO Roadmap. DoD has extensive experience in the development, certification, training, and operation of UAS and is conducting ongoing R&D efforts that partially address the other challenge categories. DoD is also providing the FAA data from earlier UAS R&D activity, testing, and operations. Most DoD efforts are focused on fielding specific DAA systems at specific locations, but DoD is also developing common requirements, architectures, and safety cases for DoD UAS to create a safe and operationally effective environment. The following challenges identified in the JPDO Roadmap are being addressed in whole or in part by DoD R&D efforts:

- Develop Integrated Separation Concepts;
- Develop Airspace Integration Safety Case/Assessment;
- Develop DAA Sensors and Fusion;
- Develop Separation Algorithms;
- Assess Availability/Quality of Surveillance Data;
- Develop Safe and Efficient Terminal Airspace Surface Operations;
- UAS Avionics and Control System Certification;
- Display of Traffic/Airspace Information;
- Effective Human-Automation Interaction; and
- Predictability and Contingency Management.

To support coordination and efficiency for meeting the UAS airspace integration challenges and goals, DoD and FAA signed a Memorandum of Understanding (MOU) that establishes an agreement and process to collaborate on UAS research and technology development initiatives. The MOU defines a framework by which FAA and DoD can work cooperatively to prioritize joint research efforts and leverage expertise and research products to meet organizational UAS research objectives.

UAS ExCom agencies are supporting the NASA UAS Integration in the NAS Project (UAS-NAS) by participating in analysis, M&S, tests, and demonstrations, as well as providing R&D data. The goal the UAS-NAS project is to reduce technical barriers associated with integrating UAS into the NAS utilizing integrated system-level tests in a relevant environment. The objective of the project is to provide research findings (validated data, algorithms, analysis, studies, and recommendations) addressing specific UAS community needs leading to routine UAS access to the NAS. The technical focus areas of the project are:

- DAA Performance Standards;
- C2 Performance Standards;
- Human System Integration;
- Integrated Test and Evaluation;
- Air Traffic Systems Integration

FAA, NASA, and DoD R&D efforts in the above technical areas and collaboration with other public agencies are key to reaching the goals and objectives in the UAS Comprehensive Plan and will provide the FAA data needed to meet the challenges identified in the FAA's Roadmap for Integration of Civil UAS in the NAS.

In the FAA Modernization and Reform Act of 2012 (FMRA), Congress directed the FAA to establish a test site program to integrate UAS into the National Airspace System. In selecting the test sites, the legislation mandated that the FAA, in consultation with the NASA and DoD, consider geographic diversity, climatic diversity, location of ground infrastructure, and research needs in choosing the sites.

On December 30, 2013, the FAA announced the selected six UAS test sites. The research and operational experiences from the UAS test sites will be used to inform the FAA's UAS Research and Development portfolio. They will also help ensure the safe integration of UAS into the Nation's airspace as we transition to a system featuring NextGen technologies and procedures. Data and other information related to the operation of UAS that is generated by the six test site operators will help the FAA answer key research questions such as solutions for "sense and avoid," command and control, ground control station standards and human factors, airworthiness, lost link procedures and the interface with the air traffic control system. This data will help the FAA to develop regulations and operational procedures for future commercial and civil use of the NAS. The test site operators are:

- University of Alaska (plan to also test in Hawaii and Oregon)
- State of Nevada
- New York's Griffiss International Airport
- North Dakota Department of Commerce
- Texas A&M University – Corpus Christi
- Virginia Polytechnic Institute and State University (plan to also test in New Jersey)

Each test site operator will manage the use and scheduling of the test site in a way that will give access to parties interested in using the site. The FAA's role is to ensure that each operator sets up a safe testing environment and to provide oversight that ensures each site operates under strict safety standards. To facilitate the standup of the test sites the FAA conducted their first test site technical interchange meeting (TIM) in March 2014. Some of the topics covered at the TIM included: the role of the UAS test sites in NAS integration; concept of operations; UAS R&D program overview; test site data and information exchange; privacy and privacy management; Certificate of Authorization or Waiver (COA) Process; steps to transition to test site civil operations; UAS airworthiness; and safety management systems. Additionally, each of the Test Sites spoke on their progress toward stand up and plans for future research and testing.

FAA approved the first test site COA on April 21, 2014, which authorized test site operations. Thus, the operational project required by the FMRA was completed more than two months ahead of the specified deadline of 180 days after test site selection. The COA was granted to the North Dakota Department of Commerce team to begin using a Draganflyer X4ES small UAS at its Northern Plains Unmanned Aircraft Systems Test Site.

Detect and Avoid Technology Development

DoD is currently pursuing an incremental approach to develop DAA capabilities that will enhance DoD's UAS access to the airspace needed to meet mission objectives. Improved UAS airspace access will enable DoD to more effectively:

- Provide direct mission support to Combatant Commanders;
- Train and maintain ready forces;
- Pursue ongoing developmental and validation activities; and
- Provide defense support to civil authorities (e.g., disaster relief, search and rescue), when needed.

As part of this incremental approach, DoD has two distinct DAA developmental efforts underway: Ground-Based Sense and Avoid (GBSAA) and Airborne Sense and Avoid (ABSAA). The DoD UAS Task Force, through the Airspace Integration Product Team (AI IPT), coordinates the Military Departments' development of both GBSAA and ABSAA capabilities. The GBSAA effort is led by the Army, though both the Air Force and the Marine Corps have fielded incrementally developed GBSAA solutions to solve immediate needs at specific facilities. A common ABSAA solution development effort is being led by the Air Force. The Navy is developing a near-term ABSAA capability to support MQ-4C Triton military operations in international airspace, which will provide beneficial information to the common ABSAA development effort.

Although GBSAA and ABSAA are separate efforts, there is significant information and technology sharing, including coordination to develop and use common avoidance algorithms and displays. DAA funding is primarily focused on research to support an incremental development approach toward fielded systems. The Army is funding the GBSAA system as part of the Gray Eagle UAS program, and the Air Force is funding ABSAA development within the Global Hawk program. Future procurement decisions will be made as the technology matures.

Ground-Based Sense and Avoid

GBSAA fielded capability will be focused on enabling UAS access to the NAS within the airport terminal area, for transits to and from special use or controlled airspace, and in Military Operations Areas (MOA). This capability will provide all-weather DAA for both day and night operations. Working closely with the FAA, the Marine Corps now has an approved GBSAA system that supports RQ-7B Shadow operations at Marine Corps Air Station (MCAS) Cherry Point, North Carolina. The Air Force has completed development of a GBSAA system to support operations at Cannon Air Force Base (AFB), New Mexico, and received approval to operate in April 2014. A fully developed GBSAA capability that allows UAS to operate in the

vicinity of other aircraft is scheduled to be in use in FY 2015 when the Army certifies and fields a GBSAA system at five MQ-1C Gray Eagle UAS operating locations.

The MCAS Cherry Point GBSAA system, originally planned as a proof-of-concept at Naval Air Station Patuxent River, Maryland, was re-directed and re-scoped to meet emerging Warfighter pre-deployment training needs at MCAS Cherry Point to transit from the airfield terminal area to and from nearby restricted airspace. Working in close coordination with the Army, the Navy/Marine Corps team developed specific processes to obtain Navy/Marine Corps qualification of the system. The MCAS Cherry Point GBSAA system provides a unique solution for the surrounding airspace, fusing information from an air traffic control radar with modified Government Off-the-Shelf (GOTS) air traffic displays. The GBSAA system was tested, validated, and approved for limited use at MCAS Cherry Point by Naval Air Systems Command in June 2011. Following a pre-employment evaluation with the use of ground observers, the system was assessed with the FAA and approved for operational use as the sole means to clear the airspace. The GBSAA system has significantly enhanced operational preparedness while reducing training and readiness costs for the operating unit; building upon these successes, new efforts are currently underway to expand the system's support to additional UAS.

The Air Force GBSAA development leverages GOTS radar and fusion/tracker hardware components to transit from Cannon AFB to nearby restricted airspace, similar to the operations at MCAS Cherry Point. This low-cost effort utilizes existing radar data to provide a traffic display to the UAS operators and new software to enhance UAS aircrew situational awareness of airborne traffic that presents a potential hazard to the UAS transit. The Air Force Safety Center worked with the Air Force Life Cycle Management Center, the Air Force Flight Standards Agency, and the Air Force Special Operations Command to develop a safety case that allowed certification and FAA approval to operate.

The Army GBSAA capability is based on an incremental development approach. The Army began this effort with the GBSAA Proof of Concept System at El Mirage, California. This effort started in FY 2009 and supported the March 2011 issuance of a COA permitting local traffic pattern operations in the vicinity of the El Mirage airfield at night. Similar to the MCAS Cherry Point and Cannon AFB systems which followed it, this first GBSAA Proof of Concept System was limited in concept and operational scope to conduct UAS operations when no other aircraft were within a pre-defined volume of airspace in the vicinity of the airfield. As a first step, this effort accepted operational limitations, but provided detailed insight into the processes for developing GBSAA system requirements and architectures; conducting a systems safety assessment; and obtaining the Military Department's qualification of the system. It also enabled significant interaction and coordination with the FAA for developing the system safety case.

The success of and lessons learned from the El Mirage GBSAA Prototype system were incorporated into the second increment of the Army GBSAA system development at Dugway Proving Ground, Utah. The Army conducted a successful demonstration of the GBSAA system at Dugway in June 2012. The 2-week demonstration used both live and synthetic aircraft flying in restricted airspace to demonstrate the functionality of the Army GBSAA system. The assessments and analysis of the data validated the design and functionality of the DAA technology while demonstrating the ability to fly unmanned aircraft (UA) using GBSAA in

numerous NAS environments including airfield traffic patterns, lateral transits, and designated operating areas below 18,000 feet mean sea level. The GBSAA system design demonstration was successful and enabled safe conduct of the missions. The Army GBSAA system is being developed in compliance with accepted airborne software certification processes, the first of its kind. Figure 1 depicts the major activity being conducted by the Army GBSAA program.

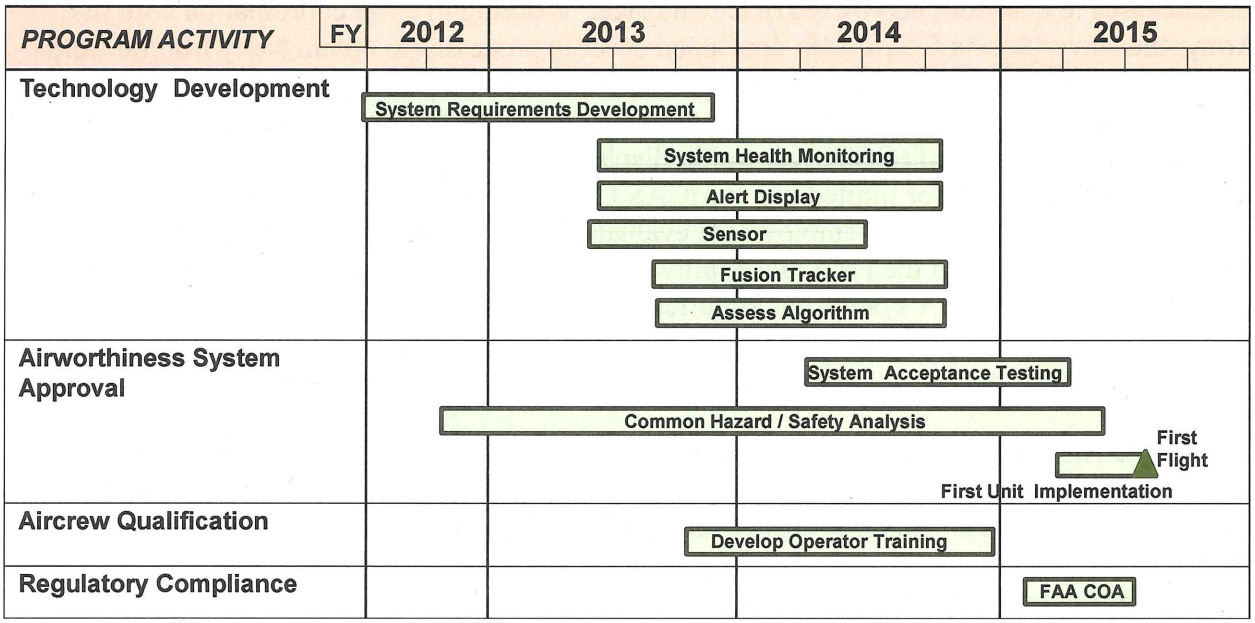

Figure 1: Army GBSAA Block 0 Major Activity and Milestones

In support of a common strategy for the development of DAA systems, the Army recommended a common set of GBSAA requirements to enable organizations interested in developing GBSAA capabilities to benefit from the work already completed. In addition, the Army GBSAA and Air Force ABSAA programs are working together to develop common DAA system display requirements.

Airborne Sense and Avoid

The goal of ABSAA is to provide a capability similar to that used by manned aircraft to permit routine airspace access for worldwide operations in non-segregated airspace. Through the use of sensors such as Automatic Dependent Surveillance–Broadcast and Traffic Alert and Collision Avoidance System to detect cooperative airborne traffic and the use of special purpose-built sensors such as electro-optical and/or air-to-air radar to detect non-cooperative traffic, the ABSAA system provides a real-time picture of the airspace in proximity of the UA.

ABSAA development has been underway since 2001 when the Air Force Research Laboratory (AFRL) started a program (Advanced UAV Flight Control Technology) that began the evaluation of sensor technologies and algorithm designs for DAA applications. The results of that effort launched a more ambitious R&D effort in 2004 that worked on developing sensing technology (i.e., cooperative and non-cooperative sensors) for reliable collision avoidance.

The Air Force and Navy are leading the DoD ABSAA development efforts. The Air Force is leading development of a common ABSAA capability to enable appropriately equipped UAS to operate in the NAS and international airspace in a manner similar to manned aircraft.

The Air Force-led common ABSAA development effort will provide a system for both day and night operations that is modular and scalable to many of the Group 3-5 UAS (UAS greater than 55 lbs). In 2005, AFRL initiated the Sense and Avoid Flight Test and Multiple Intruder Autonomous Avoidance (MIAA) programs with the support of the Global Hawk program. The MIAA effort has matured the sensor technologies and algorithms necessary to demonstrate an integrated automatic sense and avoid capability. The demonstrated capability is scalable and modular to Group 3-5 UAS and is sensor and platform agnostic to allow relatively easy integration of tailored sensors by DoD and U.S. Government (USG) Agencies.

The MIAA system has demonstrated an ABSAA capability with prototype sensors and early developmental software on a surrogate UA, a modified Learjet. Flown by CalSpan, the surrogate provided automatic maneuvering via control through the autopilot to avoid both single and multiple intruder aircraft piloted by the FAA in collision geometries in controlled airspace over the Great Lakes. This system is transitioning from the AFRL to the Air Force Life Cycle Management Center's Intelligence, Surveillance, Reconnaissance, and Special Operations Forces Program Executive Office for formal entrance into the acquisition process. Figure 2 shows the planned Common ABSAA phases and milestones.

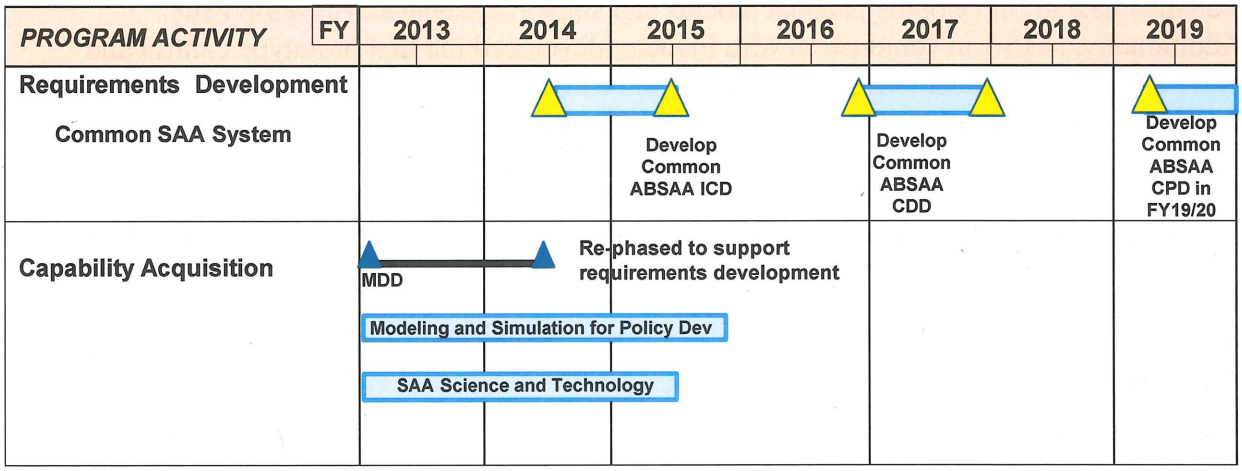

Figure 2: Common ABSAA Phase and Major Milestones

The Navy is committed to developing a near-term ABSAA capability for its MQ-4C Triton UAS to enable operations with "due regard" for the safety of other aircraft in international airspace while executing military operations. The Navy views the "due regard" ABSAA solution as a technical "path finder" for the broader common ABSAA development effort.

The ABSAA system development and certification processes are moving toward a common iterative process to be used throughout DoD. This process has been informed by the activities and lessons learned from GBSAA, close cooperation among the Military Departments,

and frequent interactions with the FAA and other governmental and non-governmental stakeholders. GBSAA and ABSAA developments are being closely coordinated and, when used together, will provide a more robust and redundant sensor capability for ABSAA-equipped UA operating in the higher traffic density terminal environments.

Command and Control Technology Development

The SC-228 Command and Control (C2) WG is working across the UAS community to develop the performance and certification standards for the UAS C2 data link. The initial phase of standards development will focus on use of L-band and C-band terrestrial data links, while the second phase is envisaged to focus on the use of SATCOM in multiple bands. In order to validate use of the spectrum under consideration for UAS, the C2 WG will establish performance characteristics and validate and verify the developed standards. Tasks include, but are not limited to, developing point-to-point and network C2 system architectures and performance allocations, exploring the potential for sharing waveform structure between L-band and C-band solutions to reduce certification, and evaluating the benefits of simultaneous or integration of L-band and C-band radios to improve system performance and improve efficiency. These products will be documented in a set of performance standards that will be adequate to support anticipated system capacity and performance.

NASA has made significant contributions through the UAS-NAS Project. During Phase 1 NASA completed L- and C-band air-ground channel propagation testing that provided technical data for developing channel models and support to standards development. Additionally, NASA in conjunction with industry developed the first prototype control and non-payload communications (CNPC) radios to be evaluated for improved design and standards development. NASA also completed a CNPC link security risk assessment to enable a set of mitigation security controls to be identified and built into the prototype CNPC system. During Phase 2, NASA plans to continue efforts to develop and validate a candidate terrestrial UAS C2 link, which includes a CNPC system prototype. NASA will continue to evaluate techniques to mitigate risk and vulnerabilities of the CNPC system and develop control communications system link models to predict performance.

Data Sharing

DoD, NASA, and FAA have been sharing UAS operational, programmatic, and R&D data for multiple years. The amount of data being shared has been steadily increasing in quantity and quality with the expansion of collaborative activities and the clarification of what data is needed for the development of standards. DoD and NASA have also provided the FAA UAS Integration Office with specific information on DoD and NASA UAS training programs and airworthiness certification processes to facilitate FAA's development of civil standards and certifications.

Operational Data

In 2011, DoD and the FAA completed an agreement on sharing UAS mishap data. Since the agreement was signed, DoD has provided two reports containing eight years of accumulated

data to the FAA regarding UAS mishap and flying hour information. This information is collected by DoD from each of the Military Department's Safety Centers and provided annually to the FAA's Director, Accident Investigation and Prevention (AVP-001). The data for FY 2013 is being gathered and will be presented to the FAA in June 2014, along with any updated data from previous years. The data is provided to the FAA Accident Investigation and Prevention Office for collection and distribution to the appropriate FAA offices for analysis.

Additional data is provided to FAA through the COA process. The FAA issues a COA to approve UAS operations outside of restricted airspace and places certain reporting requirements on the UAS ExCom agencies and other operators as a condition of that approval. UAS operational specifications, limits, and airworthiness information are provided during the COA application process. Operational data such as flight time is provided for UAS operations conducted under the COA and information regarding mishaps and other significant issues that may have occurred during flight (i.e., in-flight emergencies). The data is collected by the FAA UAS Integration Office for analysis.

The FAA and DoD, through the Policy Board on Federal Aviation, are continuing to pursue appropriate methods and data metrics that will be useful for the FAA to use in furthering UAS integration efforts. There have been several meetings to establish the type of data the FAA is interested in collecting and where that information might be accessible within DoD. Current efforts are focused on understanding each agency's method for approaching the standards used in the design, production, and continued safe operations of unmanned aircraft and their associated systems and the data collected to support these standards. Once there is a greater understanding of how each agency collects, applies, and retains this data, DoD and the FAA will be able to establish agreements to support the exchange of relevant information on a recurring and economical basis.

Programmatic and Research Data

As identified in earlier sections of this report, DoD, NASA and FAA are sharing a significant amount of data as of result of collaborative R&D activity. The location for collection, analysis, and storage is dependent on the agreements made among the participating agencies. In most cases the technical data is routed to the FAA Technical Center or the FAA NextGen Program Office and operational data to the FAA UAS Integration Office. DoD normally analyzes and stores UAS R&D data at their Military Service research centers with formal reports available through the Defense Technical Information Center.

Summary

The UAS ExCom partners have been actively engaged in developing a clear path to accelerate increased UAS access to the NAS. Collaboration in R&D, demonstrations, and data sharing have been and will continue to be a key factor in accelerating UAS integration safely and efficiently. Much work remains to ensure a complete understanding of measures needed to identify and mitigate potential risks associated with the introduction of routine UAS operations in the NAS.

The ExCom partners have worked closely in developing and demonstrating standardized DoD operating procedures that will inform the development of civil procedures. NASA's UAS-NAS project is providing key data to support standards development for the UAS community. FAA's selection of six UAS test sites and the approval to operate at the first site is a critical step that will support the FAA's development of regulations and operational procedures for future commercial and civil use of the NAS.

DoD is undertaking extensive R&D efforts to field UAS DAA systems to meet DoD mission needs. As DoD continues on the path from R&D to the fielding of UAS DAA capabilities, significant collaboration with the FAA, NASA, other USG Agencies, and private industry stakeholders will be required. With the planned initial fielding of the Army's GBSAA systems in FY 2015, the UAS community will take another step forward in the incremental approach toward developing and fielding DAA technology. As DAA capabilities mature and the regulatory framework takes shape, UAS will be able to integrate more efficiently with manned aircraft in the NAS and international airspace.

DoD, NASA and DHS are sharing significant operational, programmatic, and R&D data with the FAA to support UAS integration into the NAS. While the data from public systems has been useful for FAA's analysis, the standup of the six UAS test sites should provide the FAA with more specific and relevant data for development of civil certification, training and operating standards and procedures.

The ExCom agencies have also been extremely active in the processes to develop new policy, standards and procedures that support both the public and civil UAS integration efforts. The UAS ExCom will continue to look for opportunities where DoD, NASA, and DHS developed solution sets can be used to support the needs of other governmental and non-governmental UAS users.