Navigation Programs’ UAS Review of Technology and How to Review and Ensure Performance

Presented to:
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FAA, Navigation Programs Engineering Enterprise Services
FAA Jim Williams’ briefing - Tuesday Sept 25

- **Arctic Provisions – legislative challenges (slide 6)**
  - Commercial operations require design and production approval for all aircraft
    - Currently, there are no applicable civil standards for sUAS that may be used to certificate the aircraft

- **Implementation Approach (slide 7)**
  - Final configuration of the aircraft and operational rules will be determined by the FAA via a formal safety risk management assessment

- **Authorization (slide 12)**
  - UAS must be assessed to be “airworthy” and be authorized by AFS (in cooperation with Alaska FAA Flight Standards and Certification offices) prior to conducting flight operations in permanent areas and corridors

- **Operations (slide 13)**
  - In order to maintain compatibility with the NAS, vehicles will have to meet minimum operational criteria
UAS Technologies Review

- The ADS-B Out Final Rule, 14 CFR Part 91, defines the following parameters for navigation:

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
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<tbody>
<tr>
<td>NAC_p</td>
<td>Horizontal position accuracy &lt; 926 meters (0.5 NM)</td>
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<tr>
<td>NAC_v</td>
<td>Horizontal velocity accuracy &lt; 10 meters per second; Vertical velocity accuracy &lt; 50 meters per second (DO-260A and DO-282A)</td>
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<tr>
<td>NIC</td>
<td>Containment radius &lt; 0.2 NM</td>
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<td>SDA</td>
<td>Per flight hour probability of an avionics system failure causing false or misleading information to be transmitted from the aircraft ≤ 1 x 10^-5</td>
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<td>SIL</td>
<td>Per flight hour or per sample probability of exceeding the horizontal NIC containment radius ≤ 1 x 10^-7</td>
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- Currently only tested and approved GPS or WAAS can meet ADS-B Out navigation requirements
- Many GPS avionics **may not meet** the ADS-B Out requirements
- Backup navigation requirement - APNT
The FAA and Industry have identified gaps between navigation systems and ADS-B Out requirements

- To alleviate confusion over what meets the ADS-B Out navigation performance requirements, an ad-hoc group was formed with the FAA and industry members from WG 2, RTCA SC 159
- A matrix was developed identifying the various navigation systems and their gaps to meeting ADS-B Out requirements
- Results will be published in the upcoming appendix to AC 20-165A

<table>
<thead>
<tr>
<th>Para #</th>
<th>Vertical Position Accuracy</th>
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<tr>
<td>3.c.</td>
<td>Optional in Appendix H.</td>
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<td>4.d.</td>
<td>Verification Method</td>
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<td>Manufacturers must provide substantiation data based on the test described in attachment 1 and provide the VFOM output.</td>
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<td>3.d.</td>
<td>Requirement defined in 2.1.2.6 (1.7.1 defines HFOM + appendix H).</td>
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<td>AC 20-165</td>
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<td>TSO-C145/146 Revision b/c Class 1 (DO-229D)</td>
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<td>Required/</td>
<td>TSO-C145/146 Revision b/c Class 1 (DO-229D)</td>
<td>TSO-C145/146 Revision b/c Class 2/3 (DO-229D)</td>
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| Optional | }
WAAS 98% LPV Coverage Contours
January 1 - March 31, 2012

Alaska LPV Coverage at 98% Availability is 97.66%

W.J.H. FAA Technical Center
WAAS Test Team
UAS Technologies Review (Cont’d)

• Using SBAS (WAAS) for UAS has many benefits over GPS
  – SBAS (WAAS) eliminates RAIM checks and is not limited by GPS constellation degradations (FAA’s AC 90-100 requires RAIM check unless WAAS-equipped)
  – SBAS provides coverage over the Northern Hemisphere with WAAS, EGNOS, SDCM, MSAS, and GAGAN. International cooperation will work out any interoperability issues
  – WAAS is required for Alaska T and Q Routes, if outside of radar coverage
  – Augmented GPS (WAAS) provides better accuracy and performance over GPS; such improvements will greatly enhance UAS sense and avoid systems and/or C2

CONSIDERATION: Any chosen navigation system for UAS must be tested and meet ADS-B Out navigation requirements.
UAS Technologies Review (Cont’d)

• Detect, Sense, and Avoid Technologies
  – Civil Use Milestone: 2009 Traffic Collision Avoidance System (TCAS) on UAS Workshops
    • TCAS capabilities were reviewed to determine feasibility with UAS for three candidate functions: Self Separation, Collision Avoidance, and Situation Awareness
    • Final paper published March 21, 2011 resulting in the FAA discouraging use of TCAS in UAS for various reasons (safety, airworthiness, etc.)
    • TCAS could be integrated, in total or in part, as a component in a proposed Sense and Avoid system, but further study is required
UAS Technologies Review (Cont’d)

• Detect, Sense, and Avoid Technologies (Cont’d)
  – Public Use Milestone: 2013 Expanded Operational Capability for Remotely Piloted Aircraft (RPA) enabled by DoD Ground-Based Sense and Avoid (GBSAA)
    • Incorporates three-dimensional radar and other sensor inputs, data fusion, and software algorithms for collision avoidance
    • Allows UAS operations without ground observers or chase aircraft
    • Facilitates around-the-clock operations, day or night
  – Various Detect, Sense, and Avoid technologies being developed; ADS-B In likely to be the required underlying technology
Leveraging success and lessons learned from the historic first GBSAA flights at El Mirage – UAS flights in the NAS (night ops) in April 2011 with a qualified GBSAA system supporting Gray Eagle training

Funded to field GBSAA to Gray Eagle sites in FY14/15

Sense and Avoid Testbed at Dugway Proving Ground – 3-dimensional (3D) radar with existing (range/ATC) radar systems

Problem

• UAS need access to the National Airspace to train and support contingency operations.

• Currently, UAS do not meet Part 91.113 FAA regulation for see and avoid (No pilot onboard the aircraft - must operate with visual observers (chase planes, ground observers))

Solution

• GBSAA is a ground-based means of detecting airborne traffic and providing the necessary intelligence to the UAS to provide an alternate means of compliance to the FAA “see and avoid” regulations

Accomplishments/Updates

• Successfully validated the design and functionality of the Army’s new Phase 2 GBSAA System

• Flew live UAS on UAS vignettes which relied solely on Army Phase 2 Maneuver Algorithms to recommend maneuver action (Shadow on Shadow)

• Demonstrated versatility and adaptability of the Army system by successful conduct of vignettes targeting multiple service sites including Dugway Proving Grounds, Cherry Point (MCAS), Ft. Drum (ANG), Ft. Stewart (Army)

• Performed successful virtual flight operations in the NAS surrounding Salt Lake City, UT and Boston, MA

June 2012 Demonstration of system to be fielded to Gray Eagle training locations – GBSAA Operator in GCS

June 2012 Demo

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Provided by Jeff Blackwell, PM-UAS Ext. Programs
GBSAA Architecture

Delivering what we promised when we promised
Airborne Objects / Targets

Non-cooperative Aircraft

Class E & G Airspace

Radars

Display

Tracker

Ground Observer

Ground Control System (GCS)

Voice Communications

UAS

Avoidance Maneuvering

Air Traffic Controller (ATC)

Approved for Public Release #11-2488

Integrity - Service - Excellence
Department of Homeland Security Science & Technology (DHS S&T): Robotic Aircraft for Public Safety (RAPS)

MISSION and SCOPE

Flight test evaluation of:
– Law Enforcement Applications
– Fire/Wildfire Detection
– Radiological Detection
– Search and Rescue

Facilitate eventual user airspace access
– FAA’s Policy and COA Process
– Test parameters and criteria based on FAA’s ARC SUAS Recommendations

BENEFITS

Use SUAS to improve capabilities for:
– Real-Time Law Enforcement Operational Support
– Special Event Response
– Crime Scene Situational Awareness
– Border Security
– Fire/Wildfire Response
– Disaster Evaluation and Response

PARTNERSHIPS

– DHS Science & Technology (DHS S&T)
– U.S. Army Fort Sill test range
– OSU/University Multispectral Laboratory (UML)
– Industry/SUAS manufacturers
UAS Technologies Review (Cont’d)

• Development of UAS requirements for Public (non-civil) use continues…
  – 2012 UAS SAE Flight Controls Standards
  – 2013 Expanded Operational Capability Enabled by GBSAA
    • First system expected to be deployed in Ft. Hood by March 2014 with the remaining four sites by 2015

• Development of UAS requirements for Civil use continues…
  – 2012 Small UAS Special Federal Aviation Rule (sFAR), Part 107
  – 2012 Minimum Aviation System Performance Standards (MASPS) for UAS
    • Provides quantitative performance standards for overall UAS system. Allocates functions to subsystem
  – 2013 MASPS for Sense and Avoid (SA) Systems for UAS
    • Provides quantitative performance standards for SA subsystem
  – 2013 MASPS for Command and Communication (C2) Systems for UAS
    • Provides quantitative performance standards for C2 subsystem
How to Review and Ensure Performance

System performance is ensured through the certification process.

- UAS certification follows the current process; however, UAS-specific steps are being implemented.
Progress is being made towards UAS certification

Major Milestones

Service Bulletin (SB)

Type Certificate (TC), Supplemental Type Certificate (STC), or other

Special Airworthiness Certificate

Technical Standard Order (TSO)

MOPS

MASPS

OSED (DO-320)
Conceptual Design Phase

• DO-320, Operational Services and Environmental Definition (OSED) for UAS, Issued June 6, 2010
  – This document provides a basis for assessing and establishing operational, safety, performance, and interoperability requirements for UAS operations in the US National Airspace System (NAS). An Unmanned Aircraft System is an unmanned aircraft and its associated components and persons required for operation.
Requirements Definition Phase

- **Minimum Aviation System Performance Standards (MASPS) for UAS, Expected release: December 2012**
  - This document provides quantitative performance standards for overall UAS system. Allocates functions to subsystems

- **MASPS for Sense and Avoid (SA) Systems for UAS, Expected release: December 2013**
  - This document provides quantitative performance standards for SA subsystem

- **MASPS for Control and Communication (C2) Systems for UAS, Expected release: December 2013**
  - Provides quantitative performance standards for C2 subsystem
Requirements Definition Phase (Cont’d)

- **Minimum Operating Standards (MOPS) for UAS C2, Expected release: 2018**
  - This document provides standards for UAS C2 systems and equipment

- **MOPS for UAS SA, Expected release: 2019**
  - This document provides standards for UAS SA systems and equipment
Compliance and Implementation Planning Phases

• **Technical Standard Order (TSO) for UAS**
  - Minimum performance standard issued by the FAA for specified materials, parts, processes, and appliances used on civil aircraft

• **Special Airworthiness Certificate for UAS:** Airworthiness Certification of UAS and Optionally Piloted Aircraft, Order 8130.34B, Dated: November 28, 2011
  - Establishes procedures for issuing special airworthiness certificates in the experimental category or special flight permits to unmanned aircraft systems and optionally piloted aircraft
Compliance and Implementation Planning Phases (Cont’d)

• **Type Certificate (TC) for UAS**
  - Design approval issued by the FAA when the applicant demonstrates that a product complies with the applicable regulations

• **Supplemental Type Certificate (STC) for UAS**
  - An STC is a type certificate issued when an applicant has received FAA approval to modify an aircraft from its original design
Post Certification Phase

• **Service Bulletin (SB) for UAS**
  - the SB defines the product design change, states how the modification affects the existing type design, and lists serial number effectivity. It also identifies the certification basis listing specific regulatory compliance for the design change
Helpful Links for More Information

- FAA Unmanned Aircraft Systems (UAS) Website
  http://www.faa.gov/about/initiatives/uas/
  - Certifications and Authorizations
  - Regulations & Policies
  - Roadmap (MS PowerPoint)
  - Evaluation of Candidate Functions for TCAS On UAS
  - Questions and Answers
  - UAS Integration Office Contacts

- RTCA SC-203 UAS Website
  http://www.rtca.org/comm/Committee.cfm?id=45
  - UAS reference documents (DO-324, DO-320, etc.)
  - Information on MASPS
### Unmanned Aircraft Systems Integration Office Contacts

<table>
<thead>
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<th>Position</th>
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</tr>
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Unmanned Aircraft Program Office  
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Helpful Contacts for More Information

• FAA Aircraft Certification
  – Susan Cabler 202-385-6348
  – Rich Jennings 202-385-4562

• FAA Navigation Programs / GNSS
  – JoAnn Y Ford 202-493-4704
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Thank you!

Questions?