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TERMS OF REFERENCE
RTCA Special Committee 228
Minimum Performance Standards for Unmanned Aircraft Systems

REQUESTORS:

Organization	Person
AVS	**Jim Williams**

.

SPECIAL COMMITTEE LEADERSHIP:

Position	Name	Affiliation	Telephone	email	Change
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BACKGROUND:

Unmanned aircraft have the potential to allow civil, public, commercial, and government agencies to increase efficiency, save money, enhance safety, and even save lives. A broad range of applications and services seek to integrate these platforms into non-segregated airspace.

In order to safely integrate these platforms into non-segregated airspace, both a robust Detect and Avoid (DAA) and robust and secure Command and Control (C2) Data Link capability need to be established.

The Federal Aviation Administration (FAA) established the Unmanned Aircraft Systems Integration Office to integrate Unmanned Aircraft Systems (UAS) safely and efficiently into the National Airspace System (NAS).

To achieve this objective, the UAS Integration Office and major UAS Stakeholders are working closely with the UAS community to develop the Minimum Operational Performance Standards (MOPS) for DAA equipment, with emphasis in an initial phase of standards development on civil UAS equipped to operate into Class A airspace under IFR flight rules. The Operational Environment for the MOPS is the transitioning of a UAS to and from Class A or special use airspace, traversing Class D and E, and perhaps Class G airspace. A second phase of MOPS development is envisaged to specify DAA equipment to support extended UAS operations in Class D, E, and perhaps G, airspace.

Moreover, the UAS Integration Office is working closely to with the UAS community to develop the MOPS for the C2 Data Link. An initial phase of standards development will provide standards for the C2 Data Link using L-Band Terrestrial and C-Band Terrestrial data links. A second phase of MOPS development is envisaged to provide standards for the use of SATCOM in multiple bands as a C2 Data Link to support UAS.

DELIVERABLES:

PHASE ONE OF MOPS DEVELOPMENT

Product	Description	Due Date	Change
White Paper (see page 8 for a more detailed description of White Paper) Describing the functions, use, and options of UAS DAA Equipment when operating in transition to and from Class A airspace	This white paper defines the assumptions, envisioned approach, bounds of the approach, the core requirements for, and the approach to defining further requirements for UAS DAA Equipment to support UAS integration into the NAS when the UAS is in transition to and from Class A airspace.	**December 2013**	
White Paper (see page 8 for a more detailed description of White Paper) Describing the functions, use, and options of a C2 Data Link for UAS when operating in Non-Segregated Airspace	This white paper defines the assumptions, envisioned approach, bounds of the approach, the core requirements for, and the approach to defining further requirements for a C2 Data Link for UAS integration into the NAS. Emphasis will be given to the support of the Operational Environment for DAA above.	**December 2013**	
DAA MOPS for Verification and Validation	Develop preliminary MOPS establishing performance standards for UAS DAA Equipment in the specified Operational Environment. Includes recommendations for a Verification and Validation test program to be completed before the release of the DAA MOPS.	**July 2015**	
C2 Data Link MOPS for Verification and Validation (Terrestrial)	Develop preliminary MOPS establishing L-Band and C-Band solutions. This includes establishing performance standards for the C2 Data Link in both spectrum allocations. Includes recommendations for a Verification and Validation test program to be completed before release of the C2 Data Link MOPS.	**July 2015**	

DAA MOPS	This deliverable is the final Phase One DAA MOPS based on the results of the V & V activities.	**July 2016**	
C2 Data Link MOPS (Terrestrial)	This deliverable is the final Phase One C2 Data Link MOPS based on the results of the V & V activities.	**July 2016**	

PHASE TWO OF MOPS DEVELOPMENT

Product	Description	Due Date	Change
White Paper (see page 8 for a more detailed description of White Paper) for Phase Two DAA MOPS	This white paper defines the assumptions, envisioned approach, bounds of the approach, the core requirements for, and the approach to defining further requirements for UAS DAA Equipment to support UAS integration into the NAS when the UAS is operating on an extended basis within Class D, G, and E airspace.	**TBD**	
Phase Two DAA MOPS for Verification and Validation	Develop preliminary MOPS establishing performance standards for UAS DAA Equipment in the Phase Two Operational Environment. Includes recommendations for a Verification and Validation test program to be completed before the release of the DAA MOPS.	**TBD**	
Phase Two C2 Data Link MOPS for Verification and Validation (SATCOM)	Develop preliminary MOPS establishing SATCOM band solutions. This includes establishing performance standards for the C2 Data Link in this spectrum allocation. Includes recommendations for a Verification and Validation test program to be completed before the release of the Phase Two C2 Data Link (SATCOM) MOPS.	**TBD**	
Phase Two DAA MOPS	This deliverable is the final Phase Two DAA MOPS based on the results of the Phase Two V & V activities.	**TBD**	
Phase Two C2 Data Link MOPS (SATCOM)	This deliverable is the final Phase Two C2 Data Link (SATCOM) MOPS based on the results of the Phase Two V & V activities.	**TBD**	

SCOPE:

DAA MOPS

- The scope of DAA Working Group activities during Phase One of standards development will be to specify and validate UAS DAA Equipment performance requirements for civil UAS participating in the Operational Environment described above and performing the missions described above. In order to meet the schedules this Terms of Reference specifies, appropriate and continued focusing of DAA Working Group activities will be required.
- The Phase One DAA MOPS will be developed assuming that the requirements for UAS DAA operation while the UAS is in Class A airspace will be specified outside of the MOPS (e.g. through rulemaking) and is not part of this TOR.
- In developing the Phase One DAA MOPS, the DAA Working Group may consider, only if necessary to establish a satisfactory safety case for UAS operation, an allocation of DAA requirements between the UAS and the ground subsystem associated with the UAS.
- The Phase Two DAA MOPS will consider extended UAS operation in Class D, G, and E airspace, while the Phase One DAA MOPS will only consider UAS operation when a civil UAS equipped to operate into Class A airspace under IFR flight rules is transitioning through Class D, E, and perhaps G airspace to and from Class A or special use airspace.
- Ground taxiing by UAS will be addressed by documents external to the Phase One and Phase Two DAA MOPS and is not part of this TOR.

C2 Data Link MOPS—Phase One Activities

The focus of the C2 data link will be to provide the command and control function as the primary use of the spectrum. During a period of transition to the FAA's digital voice switch network, a secondary capability will be included on the C2 Data Link for ATC voice communications relay. It is expected that this voice communications relay function will no longer be included in the C2 Data Link once the digital voice switch network is fielded in the NAS.

ICAO has identified multiple spectrum bands as candidates for use for this C2 Data Link. These include:

- L-Band Terrestrial
- C-Band Terrestrial
- SATCOM in multiple bands

In order to validate use of the spectrum and thereby to protect the frequencies under consideration for UAS use, there is an implied urgency to define, establish performance characteristics, and validate and verify the developed standards.

As the Phase One C2 Data Link MOPS will not contain requirements for SATCOM, UAS operations using the Phase One deliverables of SC-228 will involve having any use of satellite Data Link in those operations covered through bilateral agreements between the operator and the FAA.

In developing the Phase One C2 Data Link MOPS, the C2 Data Link Working Group should discuss in detail in its White Paper deliverable which Data Link protocol levels will be defined in the MOPS. It is not anticipated that application-level message formats will be specified (as opposed to how message payloads are framed).

Complete C2 systems engineering tasks:

- Develop system architectures / performance allocations to C2 architectures, with particular focus on how differing DAA allocations may impact required C2 performance. What are the differing performance levels for different DAA architectures? Specification of the performance levels to support the DAA Architecture of the Phase One DAA MOPS will be the top priority here.
- Evaluate / determine point-to-point and network C2 architectures that must be supported.
- Evaluate potential for sharing waveform structure between L band and C band solutions to reduce certification.
- Evaluate potential / value of simultaneous operation of L band and C band to improve system performance.
- Evaluate potential / value of physical integration of L band and C band into a common radio for SWAP advantage. Or do we have L band alone, and joint L band / C band variant? Small UAS may need L band alone, larger UAS will need both and might want a single LRU.

Determine preferred MOPS structure

- Determine if a single MOPS (with L band and C band unique characteristics in appendices) is preferable to the approach of two separate MOPS

- Determine the preferred approach for ground radio requirements – Included in airborne MOPS, a separate ground MOPS, or 2 ground MOPS (L band and C band), or in a form other than MOPS.

Complete MOPS

- Determine / document the frequency allocation scheme that is adequate to support anticipated system capacity and performance.
- Determine / document physical layer waveform requirements
- Determine / document network waveform requirements.
- Determine / document upper level services that need to be co-located in the C2 LRU.
- Determine / document external interfaces.
- Write performance verification.

ENVISIONED USE OF DELIVERABLES

While SC-228 deliverables can be used by the UAS industry, the primary intent of these deliverables is for FAA (and potentially other civil aviation authorities) use in integrating UAS safely and efficiently into the NAS (or other civil airspace), with operational deployment of UAS with certified DAA and C2 Data Link equipment as soon after Phase One MOPS completion as is practical. It is the FAA's intent to invoke the MOPS through Technical Standard Orders (TSOs) and Advisory material. The work efforts leading to these products are being informally coordinated with EUROCAE and the ICAO UAS Study Group, among other bodies, to facilitate harmonization.

A. White Papers Describing the Phase One/Two DAA MOPS and C2 Data Link MOPS:

The white papers provide initial insight into the work being performed to establish performance standards for integrating UAS into the NAS. Contents of the white papers should include the following:

- Background
- Scope of this RTCA Activity
- What is addressed in this MOPS
- What is not addressed in this MOPS
- What are the assumptions of this MOPS
- Establish a set of core operational requirements that can be referenced
- What is the approach to developing the MOPS
- What are further RTCA activities (if any) expected to occur after approval of this MOPS
- MOPS development schedule
- Resource requirements
- Issues
- List of dissenting opinions on white paper contents (if any)

B. Phase One DAA MOPS

The DAA MOPS establishes the performance requirements for UAS DAA Equipment for civil UAS equipped to operate into Class A airspace under IFR Flight Rules. The Operational Environment is the UAS transitioning to and from Class A airspace through Class D, G, and E airspace. This will also include recommendations for a Verification and Validation test program.

C. UAS C2 Data Link – Terrestrial – Minimum Operational Performance Standards:

The UAS C2 Data Link MOPS establishes the performance requirements for both L-Band and C-Band terrestrial networks. This will also include recommendations for a Verification and Validation test program.

D. Phase Two DAA MOPS

The Phase Two DAA MOPS establishes the performance requirements for civil UAS operating in an extended basis in Class D, G, and E airspace. This will also include recommendations for a Verification and Validation test program.

E. UAS C2 Data Link – SATCOM – Minimum Operational Performance Standards:

The SATCOM UAS C2 Data Link MOPS establishes the performance requirements for a space-based network. This will also include recommendations for a Verification and Validation test program.

SPECIFIC GUIDANCE:

DAA and C2 Data Link recommendations and standards will be based on the premise that UAS will safely and seamlessly integrate into the NAS.

SC-228 will be provided UAS stakeholder guidance on an ongoing basis by an RTCA UAS Standards Steering Committee. The Steering Committee will meet on a regular basis to review DAA and C2 MOPS progress and focus and to ensure, along with SC-228, that stakeholder priorities are being addressed. SC-228 should in particular consult frequently with the Steering Committee while preparing the White Paper deliverables enumerated above.

A work plan for SC-228, which will be coordinated with the UAS Standards Steering Group, will be established to ensure that requirements and performance needs are documented and coordinated between the C2 Data Link Working Group and the DAA Working Group (SC-228 might find the ISRA format helpful).

The Working Group products will be developed using the RTCA MOPS Development Guidelines and considering as appropriate the methodology described in the RTCA MASPS/SPR development guidelines and the accelerated standards development methodology used by RTCA

SC-186. The committee will conduct studies and analyses of current and planned capabilities of the NAS to evaluate and present various alternatives for use in development of future products.

SC-228 will coordinate with other RTCA special committees tasked with the development of enabling systems and technologies in addition to other UAS activities (e.g. UNITE, JAA, ASTM, SAE, ICAO, EUROCAE, NATO, etc.).

SC-228 should review, in developing its deliverables, the following documents:

1) RTCA DO-320 - *Operational Services and Environmental Definition (OSED) for Unmanned Aircraft Systems*
2) FAA Concept of Operations for UAS
3) FAA UAS Road Map
4) DoD Concept of Operations for UAS – when available
5) UAS ARC Road Map
6) UAS ARC Recommendations for Small UAS
7) SC-203 DO-XXX – expected in June 2013
8) Change recommendations for FAR 91.113 -- when available
9) NextGen Unmanned Aircraft Systems Research, Development and Demonstration Roadmap (UAS RD&D Roadmap) Version 1.0. (JPDO)
10) UAS-related ICAO documents
11) UAS-related NATO documents
12) Small UAS documents from ASTM
13) UAS-related SAE documents

TERMINATION:

Special Committee 228 will terminate its activity when the Program Management Committee (PMC) approves the committee's final document. Any change/extension of the committee's work program requires prior PMC approval.