RTCA

THE GOLD STANDARD FOR AVIATION SINCE 1935

Aircraft-based Observations (ABO) Standard Setting Efforts and Status

Friends and Partners in Aviation Weather

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Purpose and Outline

- Purpose: Provide an update on standard setting activities implementing ABO via ADS-B and Mode S
- Outline
  - RTCA/EUROCAE Joint Combined Surveillance Committee and SC-206
    - DO-364 and ISRAs
    - Weather Surveillance Subgroup and Approach
  - Review of specific Mode-S/ ADS-Wx parameter implementation approaches
  - Next Steps and Other Considerations

RTCA & EUROCAE
ABO Standards Setting Activities

- RTCA/EUROCAE Combined Surveillance Committee
  - Mode S: RTCA Special Committee 209 & EUROCAE Working Group 49
  - ADS-B: RTCA Special Committee 186 Working Group 3 & EUROCAE Working Group 51 Sub-group 1
  - Weather Surveillance Subgroup (WxS SG)
- SC-206 Aeronautical Information and Meteorological Data Link Services
  - DO-339 - Aircraft Derived Meteorological Data via Data Link for Wake Vortex, Air Traffic Management and Weather Applications - Operational Services and Environmental Definition (OSED) [2012]
  - DO-360, Standards Development Activities for using Near Real-Time Aircraft-Derived Data in Future Applications [2015]
  - DO-364 - Minimum Aviation System Performance Standards (MASPS) for Aeronautical Information/Meteorological Data Link Services [2016]
  - DO-369 - Guidance for the Usage of Data Linked Forecast and Current Wind Information in Air Traffic Management (ATM) Operations [2017]
  - DO-TBD - Guidelines for In Situ Eddy Dissipation Rate (EDR) Algorithm Performance [2017]

DO-364 Weather Surveillance (WxS) Service

- Developed by RTCA SC-206 Aeronautical Information and Meteorological Data Link Services
- Section 3.3 Near Real-Time Aircraft-Based Meteorological Observation Services System Requirements and Recommendations
  - Data acquisition
  - Observation compilation
  - Transmittal timing
  - Configuration control
  - Message types
  - Operating modes
  - Based on RTCA DO-339; ICAO; WMO; and AMDAR Requirements

Inter-Special Committee Requirements Agreements (ISRA)

- Proposed by SC-206 for action by SC-186 (ADS-B MOPS) and SC-209 (Transponder MOPS)
  - Establish requirements enabling air-to-air and air-to-ground transfer of Aircraft-based Observation (ABO) meteorological parameters contained in SC-206 MASPS within the MOPS for ADS-B and ATCRBS/MODE S Airborne Equipment.
  - SC-209 and SC-186 approved ISRAs in CY2016Q4
  - CSC established WxS SG to satisfy ISRAs

WxS SG
Action, Goal, and Objectives

- Action [ALN-147]: Primarily based on RTCA DO-364, the CSC Weather Surveillance Subgroup is to determine which weather surveillance requirements and recommendations are to be implemented via ADS-B and/or Mode-S, and develop appropriate MOPS requirements, as needed.
- Goal:
  - Establish necessary and sufficient requirements enabling Modes S/ ADS-Wx based on longstanding proposals
- Objectives:
  - Ensure active, multinational, multifunctional participation in requirements development
  - Ensure completeness and correctness of requirements set
  - Complete work in time to incorporate requirements into 2019 revisions to DO-260 and DO-181

WxS SG Composition

Participant	Organization
Steve Darr (Lead)	Dynamic Aerospace, Inc.
Tim Steiner (Secretary)	FAA
Karan Hofmann	RTCA
Alex Engel	EUROCAE
Mathieu Hiale, B. Morizet, Jean Luc Robin	Airbus
Ed Hahn	ALPA
Ashutosh Sharma, Timothy Rahmes, Jesse Turner	Boeing
Frank Holzäpfel	DLR
Jörg Steinleitner	Eurocontrol
Ed Johnson, Tammy Farrar, Chris Tourigny	FAA
Todd Skoog	Garmin
Anaïs Mermet	Meteo France (SESAR/WMO)
Clark Lunsford	MITRE
Matt Erickson, Alex Rodriguez	Rockwell Collins
Curtiss Marshall, Doug Body, Frank Grooters	WMO

With apologies to anyone missed!!

WxS SG Approach

- Identify/resolve ABO reporting requirements & recommendations
- Incorporate support provided by existing ADS-B and Mode S requirements
- Develop new ADS-B and Mode S requirements, as needed
- Document and communicate results and status

Identify/Resolve ABO Reporting Requirements & Recommendations

- DO-364 MASPS: primary reference for WxS SG work, based on:
  - DO-260, DO-282, DO-339, DO-360
  - WMO AMDAR, ICAO Annex 3
- CSC Working Papers
- Other sources?
  - WMO
  - Manufacturers

Incorporate Support Provided by Existing Requirements

- Availability and performance onboard aircraft
  - No desire to revise or develop sensor standards
  - Coordination with ARINC for label information and/or development
  - Participation by manufacturers and operators
    - Sensors, data busses, avionics
- Availability for communication
  - ADS-B message sets (DO-260)
  - XPDR registers (DO-181)
  - EHS

ADS-B & Mode S MOPS Requirements Development

- SC-186 and SC-209 expertise supports WxS SG
- Develop message set requirements
  - Match ADS-Wx parameter bit requirements with open bits in ADS-B messages
  - Develop new ADS-Wx specific messages only as needed
  - Develop XPDR registers requirements for ADS-B message compilation
- Develop ADS-B report generation requirements
- DO-260 and DO-181 verbiage development

Documentation and Communication

- Family of CSC Working Papers
  - Extract DO-364 MASPS and other requirements and recommendations into ADS-Wx Overview WP
  - Develop parameter-specific WPs that evolve over time, detailing:
    - Parameter reporting requirements;
    - Parameter availability;
    - Transponder Register and Message Set requirements; and,
    - MOPS verbiage proposal.
  - Finalize ADS-Wx Overview WP
- Status updates to CSC, SC-206
- Outreach to stakeholder community

WxS SG Work Plan

- Meet monthly to assign and status actions, and propose, review and resolve WP development
- Completed Overview WP guiding approach
- ADS-Wx WP template provides guidance for parameter WP development
  - WxS SG developing parameter-specific WPs
- ADS-Wx Report Generation WPs to be developed
- Regular updates to CSC and SC-206 on status, membership, approach, and work plan

CSC WxS SG Parameter-Specific Working Papers

- Describe parameter(s) and identify offboard uses
  - MASPS & OSED provide justification
- Identify reception (update rate) requirements
  - Transmit rate to be determined by CSC
- Determine onboard availability
- Develop Mode S and ADS-B register and message set requirements
- Propose specific MOPS verbiage
- Identify coordination and harmonization actions

Mode S/ ADS-Wx Parameter Implementation Approach

Reported Parameter	DO-364	Mode S/ ADS-Wx Approach
WxS MESSAGE VERSION	Mandatory	Don't provision (enforced by TSO compliance)
VALID PARAMETERS INDICATOR	Mandatory	Adopt scheme used to incorporate into ADS messages
UNIQUE AIRCRAFT IDENTIFIER	Mandatory	Rely on inclusion of ICAO 24-bit address in all Mode S/ ADS messages- use to correlate Mode S/ ADS-Wx parameters across messages
DATA COMPRESSION STATE	Mandatory	Don't provision. No communication channel compression provided in ADS or Mode S. Limited data compression provided by bit encoding schema.
LATITUDE	Mandatory	Rely on ADS-B Compact Position Report (CPR)
LONGITUDE	Mandatory	Rely on ADS-B Compact Position Report (CPR)
PRESSURE ALTITUDE	Mandatory	Rely on ADS-B Barometric Altitude
DATE DAY	Mandatory	Rely on receiver report generation function assigned time (within 512 second epochs). If application needs longer scale time, it shall provide conversion
TIME	Mandatory	Rely on receiver report generation function assigned time (within 512 second epochs). If application needs longer scale time, it shall provide conversion

Mode S/ ADS-Wx Parameter Implementation Approach

Reported Parameter	DO-364	Mode S/ ADS-Wx Approach
STATIC AIR PRESSURE	Mandatory	Don't provision: report ADS-B Barometric Altitude to applications
STATIC AIR TEMPERATURE	Mandatory	Broadcast and Interrogable
WIND DIRECTION	Mandatory	Broadcast and Interrogable
WIND SPEED	Mandatory	Broadcast and Interrogable
ROLL ANGLE FLAG	Mandatory	Broadcast and Interrogable
MEAN EDR	Required if Equipped	Broadcast and Interrogable
PEAK EDR	Required if Equipped	Broadcast and Interrogable
WATER VAPOR	Required if Equipped	Broadcast and Interrogable
WINDSHEAR AIRSPEED CHANGE	Required if Equipped	Evaluating whether to derive from wind direction and speed

Mode S/ ADS-Wx Parameter Implementation Approach

Reported Parameter	DO-364	Mode S/ ADS-Wx Approach
TRUE AIRSPEED	Recommended	Airspeed available as part of Aircraft Status message subtype 1 (CAS if True=NA)
AIRCRAFT TYPE	Recommended	Broadcast and Interrogable Evaluate challenges of ICAO type designators
GROSS WEIGHT	Recommended	Broadcast and Interrogable Coordination with operators planned
WINGSPAN	Recommended	Broadcast and Interrogable Ground= Physical; Airborne= Effective
FLAP POSITION	Recommended	Don't provision. Evaluation determined that A/C Configuration is sufficient/redundant.
A/C CONFIGURATION	Recommended	Broadcast and Interrogable Onboard availability being evaluated.
TRUE HEADING	Recommended	Eliminated by CSC- need to evaluate impact on WxS and alternatives

Mode S/ ADS-Wx Parameter Implementation Approach

Reported Parameter	DO-364	Mode S/ ADS-Wx Approach
ICING STATUS	Optional	Broadcast and Interrogable
DEPARTURE AIRPORT	Optional	Used by AMDAR to manage message costs- NA for Mode S/ ADS-Wx
ARRIVAL AIRPORT	Optional	Used by AMDAR to manage message costs- NA for Mode S/ ADS-Wx
GNSS ALTITUDE	Optional	Sent in lieu of Barometric Altitude
ANTI-ICE	Optional	Broadcast and Interrogable

WxS SG Next Steps

- Continue coordination
  - Weather community (FAA, NOAA/NWS, AMS, WMO)
  - Other standards bodies and regulators (EUROCAE, ICAO, Eurocontrol, FAA)
  - Operators (US and European airlines)
- Implement requirements in ADS-B and Transponder MOPS
  - DO-260 (ADS-B MOPS) and DO-181 (Transponder MOPS) revisions to be published in 2019

Additional Considerations

- Harmonization of ADS-B and Mode S requirements from RTCA/EUROCAE with ICAO is ongoing
  - ICAO ADS working group meets after CSC meetings
  - ADS-Wx requirements harmonization will be needed
- Receipt of ABO by ground systems is not addressed by MOPS
  - Integration into forecast and air traffic systems needs to be planned and implemented
  - NOAA/NWS and FAA will need to enable interrogation via Mode S or receipt via ADS-B
- 2020 equipage mandate for ADS-B does not/ will not require compliance with 2019 revisions of DO-260 and DO-181

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DISCUSSION

DO-364 WxS Parameters Specifications

Reported Parameter	Unit	Range	Resolution	Reporting Requirement
WxS MESSAGE VERSION	Discrete	NA	NA	Mandatory
VALID PARAMETERS INDICATOR	String (See Note 5)	NA	NA	Mandatory
UNIQUE AIRCRAFT IDENTIFIER	Discrete	NA	NA	Mandatory
DATA COMPRESSION STATE	Discrete	NA	NA	Mandatory
LATITUDE	Degrees, Minutes, Seconds	-90 to 90 (North positive)	1 Second	Mandatory
LONGITUDE	Degrees, Minutes, Seconds	-180 to 180 (East positive)	1 Second	Mandatory
PRESSURE ALTITUDE	Feet in ICAO standard atmosphere	-1000 thru 50175 (See Note 4)	25 or 100 (See Note 5)	Mandatory
DATE DAY	Day of Month	0 thru 31	1 Day	Mandatory
TIME	UTC HH:MM:SS	0 thru 23 hrs: 0 thru 59 mins: 0 thru 60 secs	1 Second	Mandatory
STATIC AIR PRESSURE	hPa (mbar)	100 thru 1051 (See Note 6)	1 hPa (mbar)	Mandatory
STATIC AIR TEMPERATURE	Degrees Celsius	-99 thru 99	0.1 Degree	Mandatory
WIND DIRECTION	Degrees True	0 thru 359	1 Degree	Mandatory
WIND SPEED	Knots	0 thru 400	1 Knot	Mandatory
ROLL ANGLE FLAG	Discrete	Per Roll Angle Flag Table	NA	Mandatory
MEAN EDR	EDR^1/3	0.00 to 0.80	0.01	Required if Equipped
PEAK EDR	EDR^1/3	0.00 to 0.80	0.01	Required if Equipped
WATER VAPOR	Mixing ratio kg/kg	0 to 38 g/kg	1x10-6 kg/kg	Required if Equipped
WINDSHEAR AIRSPEED CHANGE	Knots	-100 thru 100	1 Knot	Required if Equipped
TRUE AIRSPEED	Knots	0 thru 800	1 Knot	Recommended
AIRCRAFT TYPE	ICAO Type or Emitter Category	NA	NA	Recommended
GROSS WEIGHT (Note 2)	Pounds	0 thru 1415000	40 Pounds	Recommended
WINGSPAN	Feet	0 to 400	1 Foot	Recommended
FLAP POSITION	Degrees	0-50	1 Degree	Recommended
A/C CONFIGURATION	Discrete	Per Aircraft Configuration Indicator Table	NA	Recommended
TRUE HEADING	Degrees	0 thru 359	1 Degree	Recommended
ICING STATUS (Note 3)	Discrete	NA	NA	Optional
DEPARTURE AIRPORT	Character	NA	NA	Optional
ARRIVAL AIRPORT	Character	NA	NA	Optional
GNSS ALTITUDE	Feet in HAE	-1000 thru 50174 (See Note 4)	25 or 100 (See Note 5)	Optional
ANTI-ICE	Discrete	NA	NA	Optional

DO-364 WxS
Input Data Ranges and Resolutions

Description	Unit	Resolution	Range
Aircraft ID	Character	N/A	N/A
Air/Ground Switch or Weight on Wheels	Discrete	N/A	N/A
Computed Airspeed	Knots	1	0 thru 800
Date Day	Day of Month	1	0 thru 31
UTC Hours	Hours	1	00 thru 23
UTC Minutes	Minutes	1	00 thru 59
UTC Seconds	Seconds	1	00 thru 59
Latitude	Degrees, Minutes, Seconds	1 Second	90 S thru 90 N
Longitude	Degrees, Minutes, Seconds	1 Second	180 E to 180 W
Pressure Altitude in ICAO Standard Atmosphere	Feet above Mean Sea Level	1	-1000 thru 50000
Static Air Temperature	Degrees Celsius	0.1	-99.9 thru +99.9
Static Pressure (Note 1)	Hectopascals (millibars)	1	900 thru 1050
Wind Direction (True)	Degrees	1	0 thru 359
Wind Speed	Knots	1	0 thru 800
Roll Angle	Degrees	1	-180 to 180
Pitch Angle	Degrees	1	-90 thru 90
Departure Station	Character	N/A	N/A
Destination Station	Character	N/A	N/A
Vertical Speed (Note 2)	Feet per Minute	1	-2000 thru 2000
Gross Weight (Note 3)	Kilogram	1	N/A
Vertical Acceleration	G	0.001	-3 thru +6
Water Vapor Data	Note 4		
Icing Status	Discrete	N/A	N/A
Anti-Ice	Discrete	N/A	N/A
Flap Position	Degrees	1	0 thru 50
Gear Position (Up/Down)	Discrete	N/A	N/A
GNSS Altitude	Feet	1	-1000 thru 50000
Groundspeed	Knots	1	0 thru 800
Track (True)	Degrees True	0.1	0.0 thru 359.9
Heading (True)	Degrees (True)	0.1	0.0 thru 359.9
True Airspeed	Knots	1	0 thru 800
Aircraft Type (ICAO or Emitter Category)	Character	N/A	N/A
Vertical Airspeed Change (Note 5)	Knots	1	-40 thru 40
Wingspan	Feet	0.1	0 thru 400

RTCA Document Types

- **Operational Services and Environmental Definition (OSED)**
  - Captures requirements that have been derived and/or validated as being necessary for a particular operational service and is used as the basis for assessing and establishing operational, safety, performance, and interoperability requirements for the related CNS/ATM system. It is often included as an attachment to a SPR.
- **Minimum Aviation System Performance Standards (MASPS)**
  - Specify characteristics that are useful to designers, installers, manufacturers, service providers and users of systems intended for operational use within a defined airspace. Where the systems are global in nature, international applications are taken in to consideration.
  - Describe the system (subsystems / functions) and provide information needed to understand the rationale for system characteristics, operational goals, requirements and typical applications. Definitions and assumptions essential to proper understanding of MASPS are provided as well as minimum system test procedures to verify system performance compliance (e.g., end-to-end performance verification).
- **Minimum Operational Performance Standards (MOPS)**
  - Provide standards for specific equipment(s) useful to designers, manufacturers, installers and users of the equipment. The word "equipment" used in MOPS includes all components and units necessary for the system to properly perform its intended function(s).
  - Provide the information needed to understand the rationale for equipment characteristics and requirements stated, describe typical equipment applications and operational goals, and establish the basis for required performance under the standard. Definitions and assumptions essential to proper understanding are provided as well as installed equipment tests and operational performance characteristics for equipment installations.
- **Safety and Performance Requirements (SPR)**
  - Used to capture the operational, safety, and performance objectives and allocate requirements for different approval types. It is developed using an operational safety assessment (OSA) and an operational performance assessment (OPA) of the functions, performance expectations, and characteristics of operational environments needed to support the Air Traffic Service (ATS) identified in the OSED.
- **Interoperability Requirements (INTEROP)**
  - Provides adequate assurance that the appropriate aspects of the relevant Communication Navigation Surveillance and Air Traffic Management (CNS/ATM) capabilities, when operating together, will perform their intended function in an acceptably safe manner for the defined operations.