



THE GOLD STANDARD FOR AVIATION SINCE 1935

**Introduction to RTCA Special Committee 206 and
Standards Development for Aeronautical
Information and Meteorological
Data Link Services Systems**

**Summer 2016 FPAW Meeting
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Purpose and Outline (formal)

- Purpose: Provide status on development and approval of standards for Aeronautical Information Services (AIS) and Meteorological (MET) Information Data Link Services by RTCA
- Outline
 - SC-206 Overview
 - Minimum Aviation System Performance Standards (MASPS) Purpose and Scope
 - MASPS Development and Status
 - Requirements and Recommendations: System, Communications Mode, Interoperability, and Verification
 - Aircraft-based Observations Requirements and Recommendations

NOTE: Charts in this format won't be briefed

Purpose and Outline (informal)

- Purpose: To let you know that a standard that includes requirements for near real time aircraft-based observation systems is nearing publication by RTCA
- Encourage you to go through the formal portion of the briefing (only informal charts will be briefed)
- Outline
 - What's a MASPS anyway?
 - What is the current status of the MASPS and when will it be published?
 - Weather Surveillance
 - What is WxS?
 - What parameters will be reported?
 - By whom? Where? When? Why? How?



SC-206 OVERVIEW



SC-206 Overview

Established in 2005 to develop standards for
Aeronautical Information Services (AIS) & Meteorological Data Link Services

Leadership

- **Co-Chairs:** Allan Hart (Honeywell) & Capt. Rocky Stone (United Airlines)
- **Designated Federal Official:** Eldridge Frazier (ANG-C61 Aviation Research Branch)
- **Secretary:** Tom Evans (NASA)
- **SG1:** (MET/Wake/ATM) Ed Johnson (FAA) & Clark Lunsford (MITRE)
- **SG4:** (EDR MOPS) Tammy Farrar (ANG-C64) & Bill Watts (Delta Airlines)
- **SG5:** (FIS-B UAT MOPS) Paul Freeman (Harris Corp) & John Ferrara (GA Pilot Consultant)
- **SG6:** (DL Services MASPS) Bill Carson (MITRE) & Stephen Darr (Dynamic Aerospace)
- **SG7:** (Guidance for DL Forecast & Real-Time Wind) Ernie Dash (AvMet) & Michael McPartland (MITLL)

Active Organizations (20)

- Air Line Pilots Association
- AvMet Applications
- Boeing
- Delta Air Lines, Inc.
- Dynamic Aerospace, Inc.
- Federal Aviation Administration
- Foreflight
- Garmin
- GE Aviation
- Harris Corporation
- Honeywell International, Inc.
- MITRE
- MIT Lincoln Laboratory
- NASA
- National Air Traffic Controllers Association
- NAV CANADA
- Panasonic Avionics Corporation
- U.S. Air Force
- United Airlines, Inc.
- World Meteorological Organization



Terms of Reference: MASPS

- Develop the MASPS for AIS and MET Data Link Services
 - Define system requirements that increase flight safety and efficiency through the transmission of meteorological and aircraft parameters to enable wake vortex, ATM, and weather applications as described in RTCA DO-339.
 - Define system requirements for downlink of aircraft derived data to support various ground based wake vortex, ATM, and weather applications, such as enhancements to Wake Turbulence Mitigation systems.
 - Define system requirements for crosslink of aircraft-derived meteorological data supporting wake vortex, ATM, and weather applications, such as those required for Flight deck-based Interval Management (FIM).
 - Define system requirements that increase flight safety and efficiency through the uplink of:
 - AIS information
 - MET information (e.g. turbulence information)



MINIMUM AVIATION SYSTEM PERFORMANCE STANDARDS (MASPS) PURPOSE AND SCOPE

What's a MASPS anyway?

- Minimum Aviation System Performance Standards (MASPS) describe the operation of a system/ application, its performance requirements, interoperability needs, and procedures for verifying performance early in its development.
- MASPS specify fairly detailed performance requirements to support the prototyping, demonstration, and further development of the application/ system.
- MASPS are not MOPS
 - Minimum Operation Performance Standards (MOPS) provide requirements for the application of pertinent technology to fulfill user needs, e.g. electronic systems and equipment that support aviation



MASPS Purpose & Scope

- Provides minimum standards for AI & MET Data Link Services systems
 - Defines system requirements based on an intended use of information transfer
- Requirements provide adequate assurance that AI and MET Data Link Services systems will function in an acceptable manner
 - Compliance is recommended as one means of assuring that systems perform satisfactorily under all conditions normally encountered in aeronautical operations
- Requirements are allocated at the system level, with some allocated to specific functions (transmit, channel, receive)
 - Requirements are also allocated to the communication mode (Broadcast, Publish-Subscribe, and Request-Reply)
 - Requirements are provided for Weather Surveillance Service systems based on an intended use of automatically and continuously compiling meteorological observations onboard aircraft and transferring that information in near real time to the ground
- Builds on previously published RTCA, EUROCAE, and other standards developed to support future ATM capabilities.
 - Describes processes and protocols for wireless communications which may use celestial or terrestrial links
 - Draws on parallels with ARINC Specification 620 (Data Link Ground System Standard and Interface Specification), and ARINC Specification 622 (ATS Data Link Applications Over ACARS Air-Ground Network).



Beyond Scope

- Because of the diversity of Data Link Services systems that could be developed, the MASPS does not attempt to define requirements for:
 - Specific data link services, other than the Weather Surveillance Service;
 - Technical services defined by organizations such as Open Geospatial Consortium; e.g., Web Feature Services;
 - Information quality, e.g., accuracy of AI or MET data;
 - Human factors considerations; message protocols; security; or,
 - External aircraft systems' use of AI or MET information
- Certification and operational approvals must be granted by approval authorities, who may use the contents of the MASPS in whole or in part
 - Use cases provide context for system safety analysis by industry



MASPS DEVELOPMENT AND STATUS



MASPS Development Approach

Appendix A

SAA
Use
Case

OPA Assessment > Performance Reqs
OSA Assessment > Safety Reqs

ETS
Use
Case

OPA Assessment > Performance Reqs
OSA Assessment > Safety Reqs

WxS
Use
Case

OPA Assessment > Performance Reqs
OSA Assessment > Safety Reqs

Appendices B & C

Common
Requirements
Analysis

System Reqs

24 Op Reqs
2 Op Recs
(Sec 3.2.1)

Comm Mode Reqs

12 Op Reqs
(Sec 3.2.2)

Interoperability

20 Reqs
5 Recs
(Sec 4.3)



DO-339 &
DO-360

Sec 3.3

Data Acquisition Requirements- 6 Perf Reqs

Observation Compilation Requirements- 24 Perf Reqs

WxS Message Type and Transmittal Requirements- 16 Perf Reqs

WxS Configuration Control Requirements- 9 Perf Reqs

Due to the TORs calling out DO-339 systems and the recommendations from DO-360, Section 3.3 provides requirements for transmission of meteorological and aircraft parameters to enable wake vortex, ATM, and weather applications via the Weather Surveillance (WxS) Service systems.



OSA & OPA Approach

Departs from DO-324 approach by performing a qualitative vs. quantitative assessment

IMMs & EMMs do not have associated probabilities

DO-264 allows for this approach with qualitative approach done previously

Guidance for converting qualitative results to quantitative probabilities (e.g., DO-350)

Deviations from “normal” approaches are noted

E.g., Fault Trees are presented in table format

Assessing Single and Multiple aircraft simultaneously

Effects of Detecting hazards or not and equivalence of OHs

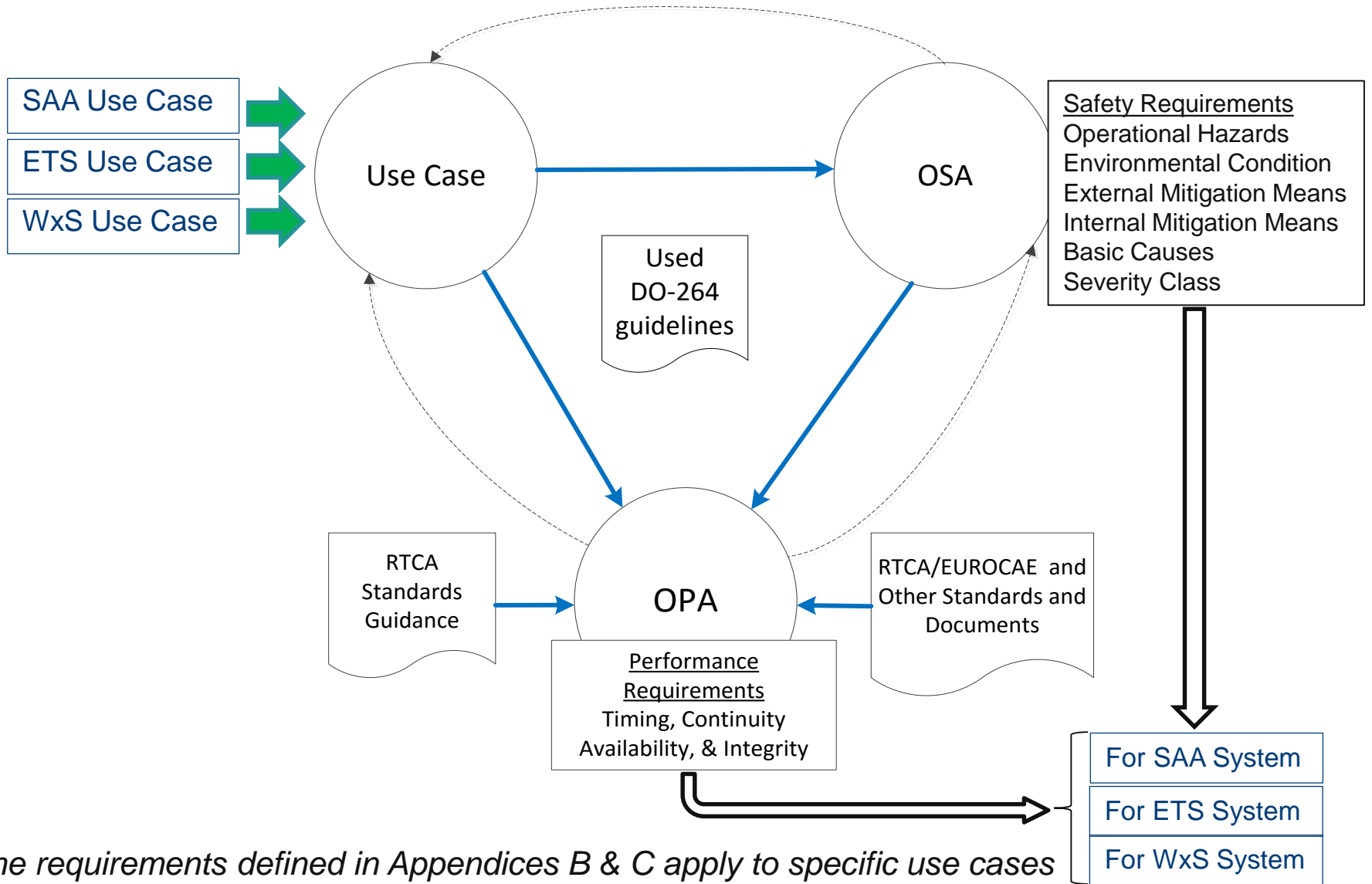
● Example OSA results

OH-SAA-01 Unavailable SAA Notification									
	Airspace with ATC Communications				Airspace without ATC Communications				
	Single		Multiple		Single		Multiple		
Effect on	Detected	Undetected	Detected	Undetected	Detected	Undetected	Detected	Undetected	
Operations	5	4	5	4	4	3	4	3	
Occupants	5	5	5	5	5	5	5	5	
Aircrew	4	4	4	4	4	3	4	3	
ATS	5	5	5	5	5	4	5	4	
SC =	5	4	5	4	4	3	4	3	

● Example OPA results

Requirements	SAA	ETS	WxS
Timing	180 TTmax / 120 TT95 sec	60 sec (update interval)	60 sec (update interval)
Continuity	0.999	0.999	0.999
Availability of Service	0.999	0.999	0.999
Integrity	0.999 with comm 0.99999 without comm	0.999	0.999

OPA/OSA Info Flow & Requirements Development



The requirements defined in Appendices B & C apply to specific use cases



Use Cases

- AIS Special Activity Airspace Notification (uplink)
 - Notifies flight crews and associated AOC/FOC of unplanned for or unexpected activation/deactivation of Special Activity Airspace that necessitates or provides opportunity for changing route
 - System description identifies a DMS (GDLPF/tDLPF), an ISP (DLSPF/cDLPF) & a CMU (ODLPF/rDLPF)
- MET Eddy Dissipation Rate Turbulence (crosslink)
 - Provides for in-flight reporting and receipt of aircraft-derived Eddy Dissipation Rate turbulence information in real time.
 - System description identifies ADS-B out (ODLPF/tDLPF) and ADS-B in (ODLPF/rDLPF)
- MET Weather Surveillance (downlink)
 - Provides aircraft-derived, geographically and temporally referenced MET information to ground-based repositories
 - System described as ADS-Wx system

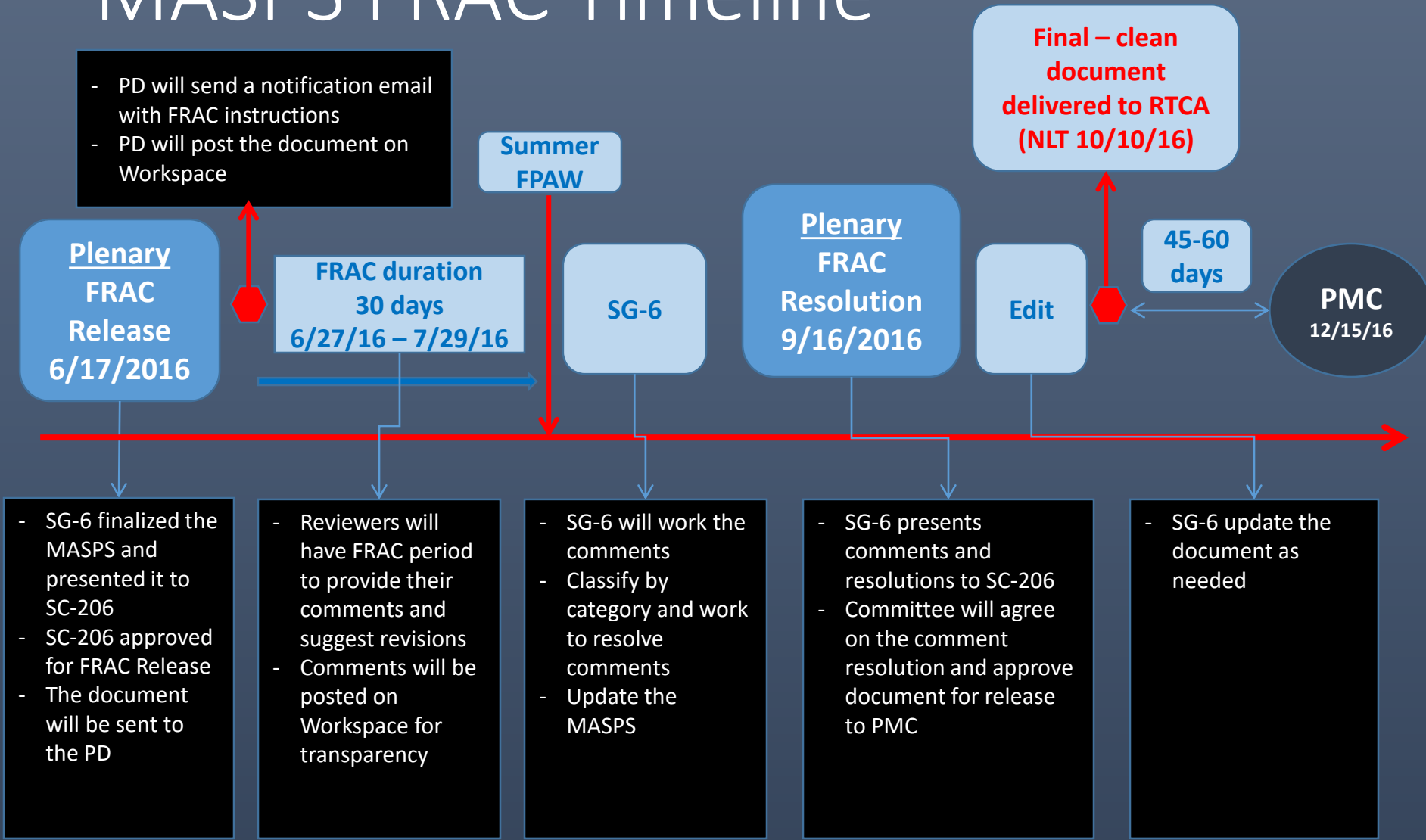
What is the current status of the MASPS and when will it be published?

MASPS Development Objectives & Status

Section	Oct 2015	Dec 2015	Mar 2016	Jun 2016	Sep 2016	Dec 2016
MASPS Development				FRAC Release	R e s o l u t i o n	M A S P S P M C A p p r o v a l
1	Red	Blue	Green	Black		
2	Red	Blue	Green	Black		
3	Red	Blue	Green	Black		
4	Red	Red	Blue	Black		
5	Red	Red	Blue	Black		
A	Red	Green	Black	Black		
B	Red	Green	Black	Black		
C	Red	Green	Black	Black		

Done / N/A
 Mature
 Needs Revision
 Needs Input (<70%)

MASPS FRAC Timeline



- PD will send a notification email with FRAC instructions
- PD will post the document on Workspace

- SG-6 finalized the MASPS and presented it to SC-206
- SC-206 approved for FRAC Release
- The document will be sent to the PD

- Reviewers will have FRAC period to provide their comments and suggest revisions
- Comments will be posted on Workspace for transparency

- SG-6 will work the comments
- Classify by category and work to resolve comments
- Update the MASPS

- SG-6 presents comments and resolutions to SC-206
- Committee will agree on the comment resolution and approve document for release to PMC

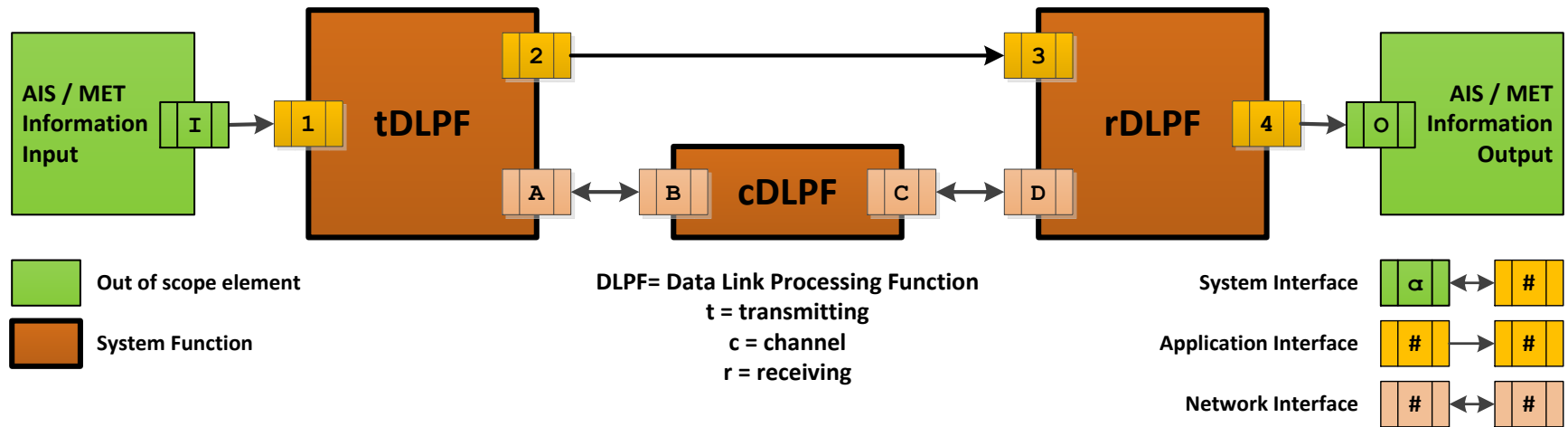
- SG-6 update the document as needed



All requirements are in draft status, with comments received during Final Review and Comment period being resolved at this time.

AI AND MET DATA LINK SERVICES SYSTEM REQUIREMENTS AND RECOMMENDATIONS

AI & MET Data Link Services System



- System description eliminates physical location references and implied transmit receive functions and directionality from those presented in earlier SC-206 documents
 - RTCA DO-340 and DO-349 used GDLPF, ODLPF, and DLSPF definitions originally established by the FAA's Aircraft Access to SWIM (AAtS) program
- The decision to change the functional descriptions in the diagram and the body of the document was made as part of the requirements development after the Use Cases and associated OSA and OPA analyses (Appendices A-C) were developed



Requirements & Recommendations

- MASPS Sections 3 and 4 establish minimum requirements that designers, manufacturers, installers, service providers, and users of AI and MET Data Link Services' systems should evaluate to determine their appropriateness, when developing, deploying and using systems
- The requirements were derived from an assessment of use case requirements (Appendices B and C) for commonality and are presented within the hierarchy of System, Communications Mode and Interoperability
 - Specific performance and safety numerical requirements are dependent on the specific Data Link Service System
 - Therefore, no numerically-based requirements are defined outside the use case specific appendices
 - Applicants will have to interpret and determine specific service system requirements if authorities invoke the MASPS
- Section 3.3: Real Time, Aircraft-based Meteorological Observation Service System
 - Per the TORs, a specific section on the requirements for implementing real time, aircraft-derived, MET observation service systems was added in support of RTCA DO-339 and in response to RTCA DO-360 recommendations
 - Aircraft-based Observation system requirements are defined only for the onboard elements of such a service and include requirements for:
 - Data acquisition range and resolution
 - Observation compilation ranges and resolutions
 - Message type and transmittal
 - Configuration control



System Requirements & Recommendations

- OR-system-01 The system shall be capable of operation in mixed equipage environments.
 - OR-system-02 The system shall not diminish the effectiveness of ATC safety services.
 - OR-system-03 The system shall not diminish the effectiveness of AOC support of safety services.
 - OR-system-04 The loss of the use of the system shall not create unacceptable safety risk.
 - OR-system-05 The system architecture shall support the intended uses.
 - OR-system-06 The Communications Effective Range of the system shall support the intended uses.
 - OR-system-07 The system shall check that the output values are consistent with the input values received at each interface.
 - OR-system-08 Procedures for system operations shall be published.
 - OR-system-09 Training material for system operations shall be published.
 - OR-system-10 The system shall have a means of determining that external sources are no longer available.
 - OR-system-11 The system shall meet minimum integrity requirements.
 - OR-system-12 The system shall meet minimum continuity requirements.
 - OR-system-13 The system shall meet minimum availability of service requirements.
 - OR-system-14 The system shall provide functionality that ensures outputs are consistent with inputs received
 - OR-system-15 The system shall provide an indication of failure(s) to properly deliver data across its communications infrastructure.
 - OR-system-16 The system shall provide an indication when required external inputs are no longer available.
 - OR-system-17 The system shall monitor integrity.
 - OR-system-18 The system shall monitor continuity.
 - OR-system-19 The system shall monitor availability of service.
 - OR-system-20 The system shall provide a means to indicate that integrity requirements are not met.
 - OR-system-21 The system shall provide a means to indicate that continuity requirements are not met.
 - OR-system-22 The system shall provide a means to indicate that availability of service requirements are not met.
 - OR-system-23 The system shall provide a means to indicate to external recipient(s) when data is no longer available.
 - OR-system-24 The system shall maintain time synchronization to within one second with UTC
-
- ORec-system-01 The cDLPF should implement an integrity check that ensures proper delivery of data across its communications infrastructure, or provides notification upon failure.
 - ORec-system-02 The cDLPF should implement a means to confirm messages are received from the tDLPF.



Communications Mode Requirements

- Broadcast Mode Requirements
 - OR-commB-01 Broadcast mode communications shall be one-way.
 - OR-commB-02 Broadcast mode communications shall be unaddressed.
 - OR-commB-03 Broadcast mode communications shall be unacknowledged.
 - OR-commB-04 In Broadcast mode, the system shall meet update interval requirements.

- Request-Reply Mode Requirements
 - OR-commRR-01 In Request-Reply mode, for addressed messages, the system shall meet maximum transaction time requirements.
 - OR-commRR-02 In Request-Reply mode, for addressed messages, the system shall meet 95% transaction time requirements.
 - OR-commRR-03 In Request-Reply mode, for addressed messages, the system shall meet minimum availability of use requirements.
 - OR-commRR-04 In Request-Reply mode, unaddressed messages shall be unacknowledged.

- Publish-Subscribe Mode Requirements
 - OR-commPS-01 In Publish-Subscribe mode, for addressed messages, the system shall meet maximum transaction time requirements.
 - OR-commPS-02 In Publish-Subscribe mode, for addressed messages, the system shall meet 95% transaction time requirements.
 - OR-commPS-03 In Publish-Subscribe mode, unaddressed messages shall be unacknowledged.
 - OR-commPS-04 In Publish-Subscribe mode, for addressed messages, the system shall meet minimum availability of use requirements.



System & External Interface Requirements

The following requirements apply at the system level:

IR-system-01 The tDLPF shall be able to communicate with the rDLPF via one or more cDLPF

IR-system-02 The system shall be capable of operation in environments in which not all aircraft are AI and MET Data Link Services system equipped

IR-system-03 The system shall provide a means to indicate to external recipient(s) when data is no longer available

IR-system-04 The system shall have a means of determining that external sources are no longer available

IR-system-05 The system shall provide a means to indicate when required external inputs are no longer available

IR-system-06 The system shall check that the outputs at interface 4 are consistent with the inputs at interface 1

IR-system-07 The system shall provide a means to indicate to external entities when the outputs at interface 4 are inconsistent with the inputs at interface 1

External Interoperability Requirements: Interface I -> 1:

IR-external-01 The tDLPF shall be able to communicate with external information source(s)

IR-external-02 The tDLPF shall be able to receive information from one or more external input(s)

IR-external-03 The tDLPF shall be able to monitor the interface(s) with external information source(s)

IR-external-04 The tDLPF shall provide a means to indicate when external inputs are no longer available

External Interoperability Requirements: Interface 4 -> O:

IR-external-05 The rDLPF shall be able to communicate with one or more external information output entities

IR-external-06 The rDLPF shall be able to send information to one or more external output(s)

IR-external-07 The rDLPF shall be able to monitor the interface(s) with one or more external information output entities



Internal Interface Requirements

Internal Interoperability Requirements: Interface 2 -> 3:

IR-internal-01 The tDLPF shall incorporate an integrity check.

IR-internal-02 The rDLPF shall incorporate an integrity check.

IRec-internal-01: The tDLPF should be able to use multiple communication channels

Internal Interoperability Requirements: Interface A -> B:

IR-internal-03 The tDLPF shall be able to communicate with one or more cDLPF

IR-internal-04 The tDLPF shall be able to exchange messages with one or more cDLPF

IRec-internal-02: The tDLPF should be able to support simultaneous connections with multiple communications channels

IRec-internal-03: The tDLPF should be able to encode messages in accordance with generally accepted international standards

Internal Interoperability Requirements: Interface C -> D:

IR-internal-05 The rDLPF shall be able to communicate with one or more cDLPF

IR-internal-06 The rDLPF shall be able to receive data from one or more cDLPF

IRec-internal-04 The rDLPF should be able to support simultaneous connections with multiple communications channels

IRec-internal-05 The rDLPF should be able to decode messages in accordance with generally accepted international standards



Verification Guidance

- The purpose of this section is to provide guidance to stakeholders relating performance verification and system tests to performance requirements.
 - This guidance is not intended to establish procedural detail for how to conduct verification testing for each requirement.

- A plan, or equivalent formalization of verification activities, should be developed to ensure proper traceability and compliance with performance requirements. It should address the following points:
 - Who: Clear identification of the individuals and/or organizations involved in the activities and the roles and responsibilities of each team member should be defined;
 - What: The objectives of verification should be defined, establishing acceptance criteria and methods for verification of the requirements; and,
 - How: The plan should define the activities and specify the required documentation necessary to demonstrate compliance with all requirements.

- Process Methodology
 - Any combination of the following methods can support system performance verification:
 - Demonstration
 - Examination
 - Analysis
 - Test



All requirements are in FINAL REVIEW DRAFT status, with comments received during the Final Review and Comment period being resolved.

AIRCRAFT-BASED OBSERVATION (AbO) REQUIREMENTS AND RECOMMENDATIONS

What is Weather Surveillance (WxS)?

- The Weather Surveillance (WxS) use case proposes the periodic, immediate broadcast of aircraft-based observations, extending AMDAR and similar aircraft-based observation system requirements to near real time reporting.
- The requirements for WxS onboard systems are derived from the WxS use case, RTCA DO-339, and requirements and recommendations found in ICAO Annex 3 and in the AMDAR Onboard Software Functional Requirements Specification (AOSFRS). They are biased toward extending existing requirements rather than obviating them.

What parameters will be reported?

Mandatory Parameters (if participating and equipped)

- Observation reference
 - Lat/Long, Pressure Altitude
 - Date, Time
- Meteorological
 - Static Pressure and Temperature
 - Wind Direction and Speed (with quality flag)
 - Eddy Dissipation Rate (if equipped)
 - Water Vapor (if equipped)
 - Windshear (if equipped)

Recommended and Optional Parameters

- Aircraft Status
 - Size (wingspan, gross weight, type/emitter type)
 - Configuration (flaps, airspeed, heading)
- Optional
 - Icing & Anti-ice Status
 - Departure & Arrival Airports
 - GNSS Altitude

By whom? Where? When? Why? How?

- By whom?
 - Voluntarily equipped aircraft from individual GA thru commercial fleet operators
- Where?
 - Wherever equipped aircraft are operating
- When?
 - From Out thru In
 - Every 60 seconds for low-rate reporting
 - Every 10 seconds for high-rate reporting
- Why?
 - To characterize the atmosphere in support of wake, weather forecasting, and ATM applications, and others TBD
- How?
 - Automatically, accessing best onboard sources, to repositories unspecified, via data link



AbO Data Acquisition Requirements

- PR-AbO-01 WxS onboard system data acquisition shall be accomplished by integrating data sources, or interoperating with external aircraft systems, to ensure compliance with the sensing and/or derivation, compilation, and transmittal requirements for reported parameters.
- PR-AbO-02 WxS systems shall use the last valid sample for all input data when reporting or deriving observation parameters.
- PR-AbO-03 WxS systems shall only use input data that is validated using applicable avionics standards.
- PR-AbO-04 WxS systems shall only use input data that passes out of range checks for the parameter ranges specified in the Input Data Range and Resolution table.
- PR-AbO-05 WxS systems shall only use valid input data for calculations.
- PR-AbO-06 WxS systems shall only use valid input data for derivation of parameters.

WxS Input Data Ranges and Resolutions

Description	Unit	Resolution	Range	Preferred Acquisition Rate
Aircraft ID	Character	N/A	N/A	N/A
Air/Ground Switch or Weight on Wheels	Discrete	N/A	N/A	1 Hz
Computed Airspeed	Knots	1	0 through 800	1 Hz
Date Day	Day of Month	1	0 through 31	1 Hz
UTC Hours	Hours	1	00 through 23	1 Hz
UTC Minutes	Minutes	1	00 through 59	1 Hz
UTC Seconds	Seconds	1	00 through 59	1 Hz
Latitude	Degrees, Minutes, Seconds	1 Second	90 S through 90 N	1 Hz
Longitude	Degrees, Minutes, Seconds	1 Second	180 E to 180 W	1 Hz
Pressure Altitude in ICAO Standard Atmosphere	Feet above Mean Sea Level	1	-1000 through 50000	1 Hz
Static Air Temperature	Degrees Celsius	0.1	-99.9 through +99.9	1 Hz
Static Pressure (Note 1)	Hectopascals (millibars)	1	900 through 1050	1 Hz
Wind Direction (True)	Degrees	1	0 through 359	1 Hz
Wind Speed	Knots	1	0 through 800	1 Hz

Description	Unit	Resolution	Range	Preferred Acquisition Rate
Roll Angle	Degrees	1	-180 to 180	1 Hz
Pitch Angle	Degrees	1	-90 through 90	1 Hz
Departure Station	Character	N/A	N/A	N/A
Destination Station	Character	N/A	N/A	N/A
Vertical Speed (Note 2)	Feet per Minute	1	-2000 through 2000	1 Hz
Gross Weight (Note 3)	Kilogram	1	N/A	1 Hz
Vertical Acceleration	G	0.001	-3 through +6	8 Hz
Water Vapor Data	Note 4			1 Hz
Icing Status	Discrete	N/A	N/A	1 Hz
Anti-Ice	Discrete	N/A	N/A	1 Hz
Flap Position	Degrees	1	0 through 50	1 Hz
Gear Position (Up/Down)	Discrete	N/A	N/A	1 Hz
GNSS Altitude	Feet	1	-1000 through 50000	1 Hz
Groundspeed	Knots	1	0 through 800	1 Hz
Track (True)	Degrees True	0.1	0.0 through 359.9	1 Hz
Heading (True)	Degrees (True)	0.1	0.0 through 359.9	1 Hz
True Airspeed	Knots	1	0 through 800	1 Hz
Aircraft Type (ICAO or Emmitter Category)	Character	N/A	N/A	N/A
Windshear Airspeed Change (Note 5)	Knots	1	-40 through 40	1 Hz
Wingspan	Feet	0.1	0 through 400	N/A



AbO Observation Compilation Requirements and Recommendations

- PR-AbO-07 Reported parameter values shall be obtained or derived from the highest frequency instantaneous sample available, closest to the observation time, and in compliance with the data validation requirements.
- PR-AbO-08 In suitably equipped aircraft, WxS systems shall derive EDR.
- PR-AbO-09 In suitably equipped aircraft, mean turbulence intensity (EDR) shall be calculated for each minute while the aircraft is operating.
- PR-AbO-10 In suitably equipped aircraft, peak turbulence intensity (EDR) shall be calculated for each minute while the aircraft is operating.
- PR-AbO-11 In suitably equipped aircraft, WxS systems shall comply with the EDR calculation requirements specified in AOSFRS Appendix C, Section C.1.2.1 and in the EDR Algorithm Overview section of the NCAR In Situ Vertical winds-based EDR Estimation Algorithm Description v0.9.
- PR-AbO-12 In suitably equipped aircraft, WxS systems shall comply with the Water Vapor sensing and calculation requirements specified in AOSFRS Appendix C, Section C.2.
- PR-AbO-13 When reporting Aircraft Configuration Indicator, WxS systems shall comply with the requirements specified in the Aircraft Configuration Indicator table.
- PR-AbO-14 WxS observations shall be stored in a dedicated area of memory until transmitted.
- PR-AbO-15 WxS systems shall report each of the parameters identified in the Header Data Block and Data Blocks 1 and 2 in Table 3-4 Aircraft-based Observation Parameter Specification Table.
- PR-AbO-16 In suitably equipped aircraft, WxS systems shall report each of the parameters identified as Required if equipped in Data Block 2 in Table 3-4 Aircraft-based Observation Parameter Specification Table.

- PRec-AbO-17 WxS systems should report each of the parameters identified in Data Block 3 in Table 3-4 Aircraft-based Observation Parameter Specification Table.
- PRec-AbO-18 WxS systems may report each of the parameters identified in Data Block 4 in Table 3-4 Aircraft-based Observation Parameter Specification Table.



AbO Observation Compilation Requirements

- PR-AbO-19 WxS systems shall either mask or not report invalid data.
- PR-AbO-20 WxS systems shall compile observations continuously while the aircraft is operating.
- PR-AbO-21 WxS systems shall compile observations that comprise the elements shown in Table 3-4 in compliance with the units, range, resolution, and reporting requirements noted.
- PR-AbO-22 Input values for each measured datum shall be reported in the current observation.
- PR-AbO-23 For each parameter in the observation, the Valid Parameter Indicator shall indicate whether valid data is contained in the observation.
- PR-AbO-24 WxS systems shall mask invalid data within observations rather than reporting it
- PR-AbO-25 When reporting wind values, WxS systems shall report a Roll Angle Flag that complies with the requirements specified in the Roll Angle Flag table.
- PR-AbO-26 When reporting Water Vapor, WxS systems shall report the water content of the air in the native measurement units of the sensor or system used to measure or derive the parameter.
- PR-AbO-27 Each WxS Observation Message shall include exactly one value for each parameter reported.
- PR-AbO-28 WxS Messages shall be identified as such when transmitted.
- PR-AbO-29 WxS Messages shall include a software version indicator.
- PR-AbO-30 WxS Messages shall be compiled immediately prior to transmittal.

AbO Parameter Specifications

Data Block	Reported Parameter	Unit	Range	Resolution	Reporting Requirement
Header	WxS MESSAGE VERSION	Discrete	NA	NA	Mandatory
Header	VALID PARAMETERS INDICATOR	Binary	NA	NA	Mandatory
Header	UNIQUE AIRCRAFT IDENTIFIER	Discrete	NA	NA	Mandatory
Header	DATA COMPRESSION STATE	Discrete	NA	NA	Mandatory
1 (Note 1)	LATITUDE	Degrees, Minutes, Seconds	-90 to 90 (North positive)	1 Second	Mandatory
1 (Note 1)	LONGITUDE	Degrees, Minutes, Seconds	-180 to 180 (East positive)	1 Second	Mandatory
1 (Note 1)	PRESSURE ALTITUDE	Feet in ICAO standard atmosphere	-1000 through 50000	10 Feet	Mandatory
1	DATE DAY	Day of Month	0 through 31	1 Day	Mandatory
1	TIME	UTC HH:MM:SS	0 through 23 hours: 0 through 59 minutes: 0 through 60 seconds	1 Second	Mandatory
2	STATIC AIR PRESSURE	hPa (mbar)	-1000 through 50000	1 hPa (mbar)	Mandatory
2	STATIC AIR TEMPERATURE	Degrees Celsius	-99 through 99	0.1 Degree	Mandatory
2	WIND DIRECTION	Degrees True	0 through 359	1 Degree	Mandatory
2	WIND SPEED	Knots	0 through 800	1 Knot	Mandatory
2	ROLL ANGLE FLAG	Discrete	Per Roll Angle Flag Table	NA	Mandatory
2	MEAN EDR	$\epsilon^{1/3}$	0 to 2	0.001	Required if Equipped
2	PEAK EDR	$\epsilon^{1/3}$	0 to 2	0.001	Required if Equipped
2	WATER VAPOR	Mixing ratio kg/kg	0 to 38 g/kg	1x10 ⁻⁶ kg/kg	Required if Equipped
2	WINDSHEAR AIRSPEED CHANGE	Knots	-40 through 40	5 Knot	Required if Equipped
3	TRUE AIRSPEED	Knots	0 through 800	1 Knot	Recommended
3	AIRCRAFT TYPE	ICAO Type or Emitter Category	NA	NA	Recommended
3	GROSS WEIGHT (Note 2)	Pounds	0 through 1415000	40 Pounds	Recommended
3	WINGSPAN	Feet	0 to 400	1 Foot	Recommended
3	FLAP POSITION	Degrees	0-50	1 Degree	Recommended
3	A/C CONFIGURATION	Discrete	Per Aircraft Configuration Indicator Table	NA	Recommended
3	TRUE HEADING	Degrees	0 through 359.9	0.1 Degree	Recommended
4	ICING STATUS (Note 3)	Discrete	NA	NA	Optional
4	DEPARTURE AIRPORT	Character	NA	NA	Optional
4	ARRIVAL AIRPORT	Character	NA	NA	Optional
4	GNSS ALTITUDE	Feet	-1000 through 50000	1 Foot	Optional
4	ANTI-ICE	Discrete	NA	NA	Optional



WxS Message Types

WxS Message	Description
Message Header	Not a Message itself, but the elements that are part of all Messages
Observation Message	Message that contains a Header and exactly one observation. Observation Messages are the same for Broadcast, Publish, and Reply communications modes
Observation Subscription Message	Message that contains a Header and an Observation Subscription
Observation Request Message	Message that contains a Header and an Observation Request
Configuration Request Message	Message that contains a request for a Configuration Status Message
Configuration Status Message	Message that contains a Header and the configuration settings for the WxS system
Optimization Message	Message that contains a Header and the parameters DEPARTURE STATION and DESTINATION STATION



WxS Observation Message Reception Rates

- WxS Observation Message reception rates are based on the goal of characterizing the atmosphere in terms of its air mass movements, stability, density, and humidity, in support of existing and proposed services that rely on aircraft observations.
- A 60-second, low-rate reception period is associated with characterizing the atmosphere through continuous reception of AbO parameters.
 - Continuous updating of AbO parameters argues in favor of Broadcast mode or Publish-Subscribe mode communications.
- Certain applications require AbO parameters to be reported at higher rates. For such applications, a 10-second, high-rate reception period is provided on the basis that the high rate reception requirements would be of limited duration.
 - Publish-Subscribe mode or Request-Reply mode communications could satisfy such requirements.



WxS Transmittal Requirements and Recommendations

- PR-AbO-31 WxS systems shall use a time-based observation reporting scheme.
- PR-AbO-32 WxS systems shall report observations beginning with the OUT event.
- PR-AbO-33 WxS systems shall cease reporting observations following transmittal of the observation closest to the IN event.
- PR-AbO-34 WxS observations shall be reported in all phases of flight, including taxi, takeoff, ascent, level flight, descent, and landing.
- PR-AbO-35 WxS systems shall transmit observations in compliance with subscription requirements.
- PR-AbO-36 WxS systems shall transmit observations in compliance with request requirements.
- PR-AbO-37 Transmission of WxS observations shall be made so as to ensure a 95% probability of reception of an observation, within the effective range of the transmitter, within the required reception period for the operating mode.
- PR-AbO-38 WxS systems shall be able to satisfy Publication or Reply mode communications requirements while simultaneously satisfying Broadcast mode communications requirements.
- PR-AbO-39 WxS systems shall discard observations after they are transmitted.
- PR-AbO-40 WxS Messages shall be transmitted with error detection provisions.
- PRec-AbO-41 Addressed WxS Messages may be transmitted with error correction provisions.
- PRec-AbO-42 WxS systems should be capable of transmitting a WxS Optimization Message.
- PRec-AbO-43 WxS systems should be capable of transmitting a WxS Status Message.
- PR-AbO-44 If enabled, WxS Configuration Messages shall be requested by data link transmittal of a WxS Configuration Request Message.
- PRec-AbO-45 A WxS optimization message may be sent to the National Meteorological and Hydrological Service and/or airline prior to departure of every flight.
- PRec-AbO-46 Data compression may be used to reduce message size.



WxS Configuration Control Requirements and Recommendations

- PR-AbO-47 WxS systems shall be default configured to operate in Low Rate Broadcast mode.
- PR-AbO-48 WxS systems shall be configurable to operate temporarily in Low Rate Publication, High Rate Publication or High Rate Reply modes through receipt of a Subscription or Request message.
- PR-AbO-49 WxS systems shall return to their default configuration if reconfiguration fails or is lost.
- PR-AbO-50 WxS systems shall be able to be turned off for the duration of the current flight, for up to 99 flights, or until turned back on, after which the configuration will revert to the default configuration.
- PR-AbO-51 If the WxS system is turned back on after being switched off for the duration of the current flight, for up to 99 flights, or until turned back on, it shall return to nominal operation within one low rate reception period after startup is complete.
- PRec-AbO-52 WxS systems should be configurable to enable or disable reporting in a minimum of 10 geographical boxes defined by two latitude/longitude coordinate pairs. Outside these boxes reporting is enabled or disabled depending on the airport limitation status.
- PRec-AbO-53 WxS systems should be configurable to enable or disable reporting around a minimum of 20 and up to 50 airports. The settings applied to these specific locations shall take priority over the geographical limiting function.
- PRec-AbO-54 It should be possible to configure a single time window during which reporting is inhibited. This setting shall have priority over all other settings except turning off reporting.
- PRec-AbO-55 WxS systems should provide a means to obtain the current configuration from the system through a Configuration Request Message.

Discussion