ADS-B Weather Development

Friends and Partners in Aviation Weather
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Background

- Using aircraft as weather observation platforms has a long history, beginning with Pilot Reports (PIREPs) and continuing into automated Aircraft Reports (AIREPs) [see notes]

- Today, the FAA shares cost of AIREPs via AMDAR (Aviation Meteorological Data Relay) with commercial operators
  - Each AIREP message incurs communication service costs

- ABO is being incorporated into ADS-B Version 3 as ADS-B Wx
  - ADS-B Wx data range and resolution and reception range and interval requirements have been closely coordinated with users
  - ADS-B Wx vastly increases ABO reporting
  - ADS-B Wx dramatically reduces ABO costs
    - No per message costs
    - The ADS-B receiver system is already operating
    - ADS-B V3 updates to receiver network are expected

Changes to ADS-B: V2 to V3

- **Who**
  - RTCA/EUROCAE committees and ICAO panels
- **What**
  - Globally-harmonized, government/industry consensus standards for ADS-B V3
    - ADS-B V2 is current global standard
- **Where**
  - New ADS-B Out and ADS-B In avionics for forward fit and retrofit
  - ADS-B Rule Airspace compliance
- **When**
  - ADS-B V3 consensus standards to be published in 2020 (1090 MHz) and 2021 (UAT)
  - ADS-B V3 regulations to be published in 2021 (1090 MHz) and 2022 (UAT)
  - ADS-B V3 avionics could be available by 2022 (1090 MHz) and 2023 (UAT)
- **Why**
  - Remove unused V2 requirements and correct errors
  - Add requirements supporting ADS-B In (air-to-air) and ground-based applications
- **How**
  - Publish RTCA/EUROCAE MOPS and ICAO standards revisions
  - Invoke standards in regulations affecting aircraft and airspace

- Specify ADS-B message formats, broadcast intervals, and other broadcast requirements

- International ADS-B implementations broadcast Extended Squitters (ES) on 1090 MHz Mode S transponders

- US implemented dual-link approach
  - Mode S transponders broadcasting ES on 1090 MHz (required for Class A airspace)
  - ADS-B devices broadcasting on 978 MHz (UAT)

- US ADS-B Out Rule specifies functions and airspaces for broadcast of messages

- ADS-B Out message definitions incorporating weather and other parameters supporting air traffic, wake turbulence, and weather forecasting applications

- Mode S transponders and ADS-B Out devices with native capability to accept ADS-B Wx inputs, assemble and broadcast messages

- Operator choice with respect to connection of inputs supporting broadcast of messages (no equipage mandate)

Aircraft Status Message

- Subtype 1 (Emergency/ Priority Status)
  - Mean EDR
  - Peak EDR and Offset
  - Airspeed (scalar)

ADS-Wx Messages

- Subtype 0 (Aircraft State)
  - Aircraft Configuration
  - Aircraft Type
  - Gross Weight
  - Wingspan

- Subtype 1 (Weather State)
  - Icing Status
  - Wind Quality Indicator
  - Wind Velocity (vector)
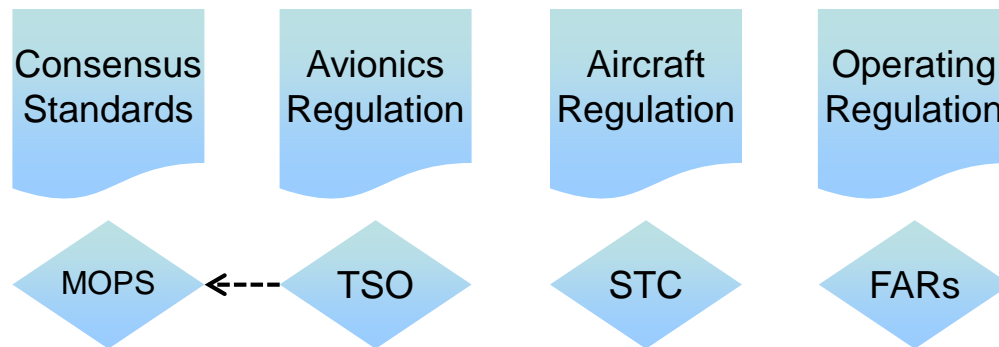 - Static Air Temperature
  - Water Vapor

- **Air Traffic**
  - Routine weather surveillance [1,2] and hazardous weather detection and avoidance [1,2]
  - Interval management [1,2]
  - Traffic awareness [2]

- **Wake Turbulence**
  - Hazardous wake avoidance in en route and terminal airspace [1,2]
  - Wake surfing [2]

- **Weather Forecasting [1]**
  - Rapid-update observations enable rapid-update forecasts
  - Improved hazardous weather detection and prediction
  - Forecast skill and feature size improvements
  - NWP model performance improvements

[1] **Ground-based**
[2] **Flight Deck-based**

- Continue ADS-B Wx development
  - MOPS verbiage
  - ADS-B Wx parameter derivation requirements
  - ADS-B In report generation requirements

- Continue coordination with:
  - Weather community (FAA, NOAA/NWS, AMS, WMO, FPAW);
  - Other standards bodies and regulators (EUROCAE, ICAO, Eurocontrol, FAA); and,
  - Manufacturers and Operators.

- Harmonize UAT and 1090 ES ADS-B Wx

- ADS-B V3 messages could be available from avionics beginning in 2022
  - Ground receipt and distribution planning for ADS-B Wx information will require continued coordination with users to maximize benefits

- Integration into forecast and air traffic systems needs to be planned and implemented
  - Receipt of ABO by ground systems is not specified by MOPS

ENSURING SIGNAL-IN-SPACE

Steps to Signal-in-Space

Consensus Standards	Avionics Regulation	Aircraft Regulation	Operating Regulation
MOPS ←---	TSO	STC	FARs

- Consensus standards (MOPS) are referenced and adopted or not by equipment regulations (TSO).
- Certification to TSO ensures equipment meets requirements.
- STC permits installation of equipment in aircraft.
- Operating aircraft with equipment requires compliance with operator and airspace regulations (FARs)

- Whether ADS-B Wx is part of future avionics is dependent on standards and regulations.
- Multiple approaches can achieve signal-in-space.
- Operator and/or airspace regulations can influence both avionics functionality and equipage.
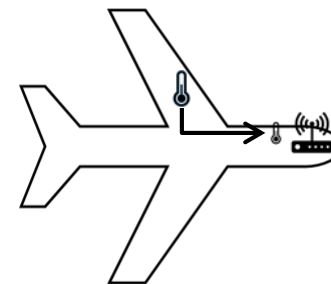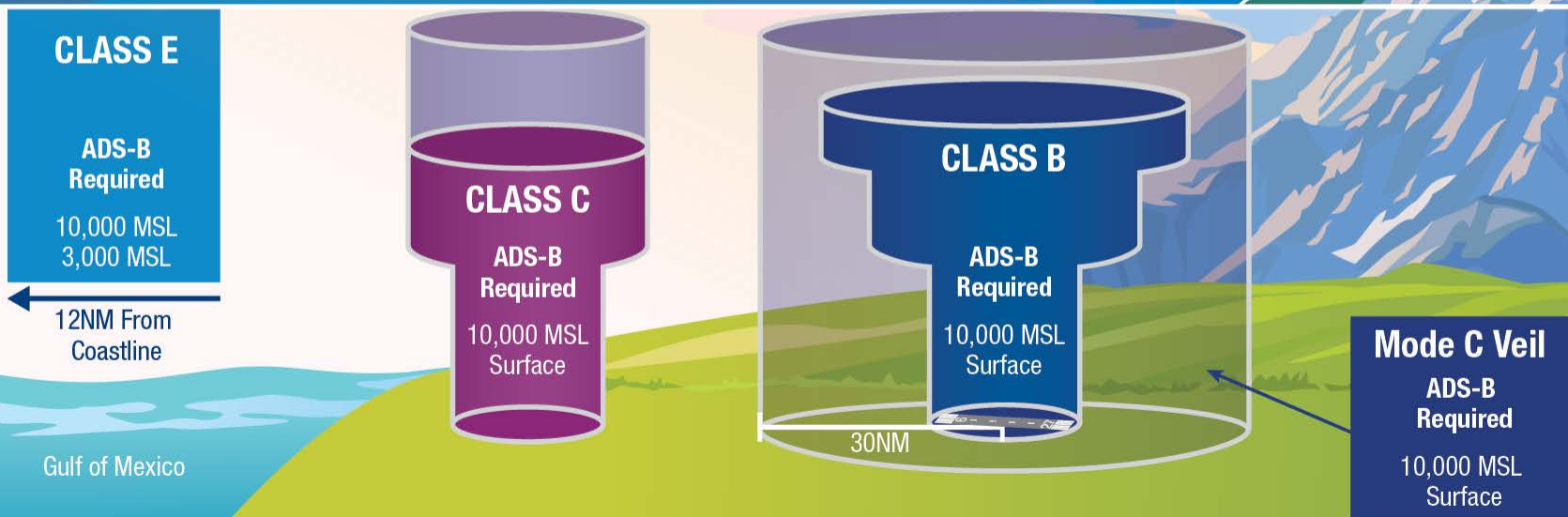
US ADS-B Rule Airspace


FL 600
18,000 MSL

CLASS A │ ADS-B 1090 ES Required

CLASS E │ 10,000 MSL and above ADS-B Required

2,500 AGL
ADS-B Not Required

CLASS E

ADS-B Required

10,000 MSL
3,000 MSL

12NM From Coastline

Gulf of Mexico

CLASS C

ADS-B Required

10,000 MSL
Surface

CLASS B

ADS-B Required

10,000 MSL
Surface

30NM

Mode C Veil

ADS-B Required

10,000 MSL
Surface

Key | AGL: Above Ground Level; FL: Flight Level; MSL: Mean Sea Level; NM: Nautical Miles

Consensus Standards

Avionics Regulation

Aircraft Regulation

Operating Regulation

MOPS ← - - - TSO → STC FARs
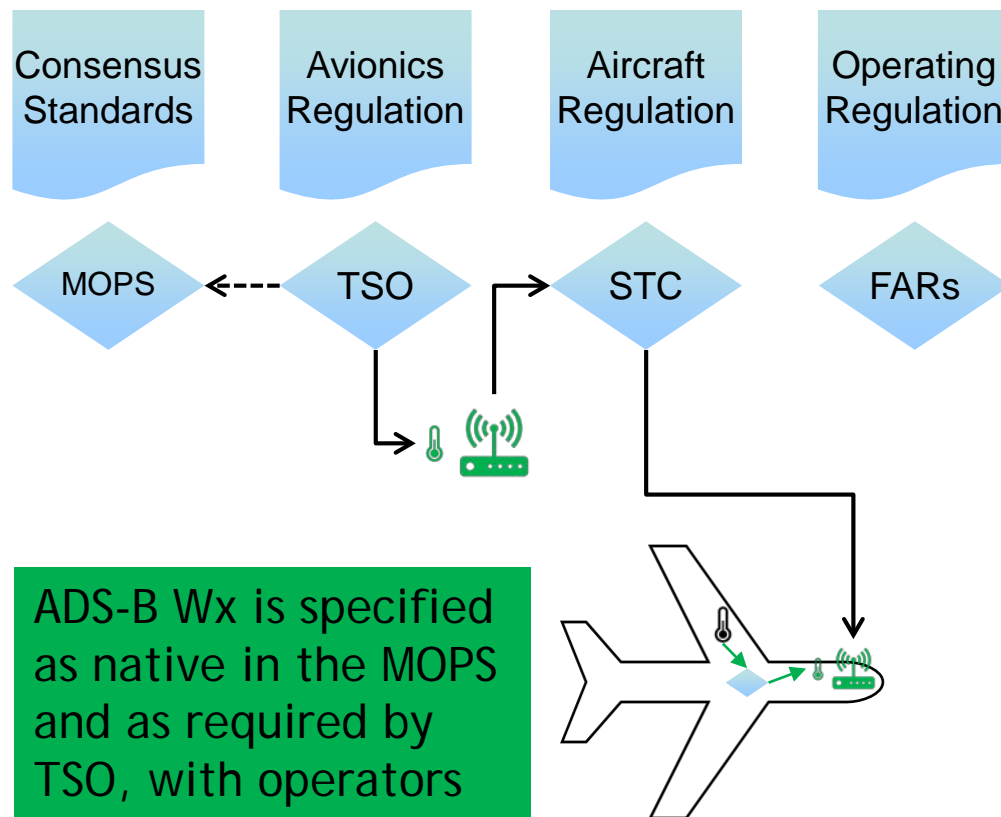
ADS-B Wx is specified as native in the MOPS and as required by TSO, with operators free to choose whether to connect ADS-B Wx inputs.

ADS-B Wx is enabled on the basis of standards, avionics regulation, and the interests of operators.

Ensuring Signal-in-Space

Consensus Standards — MOPS

Avionics Regulation — TSO

Aircraft Regulation — STC

Operating Regulation — FARs
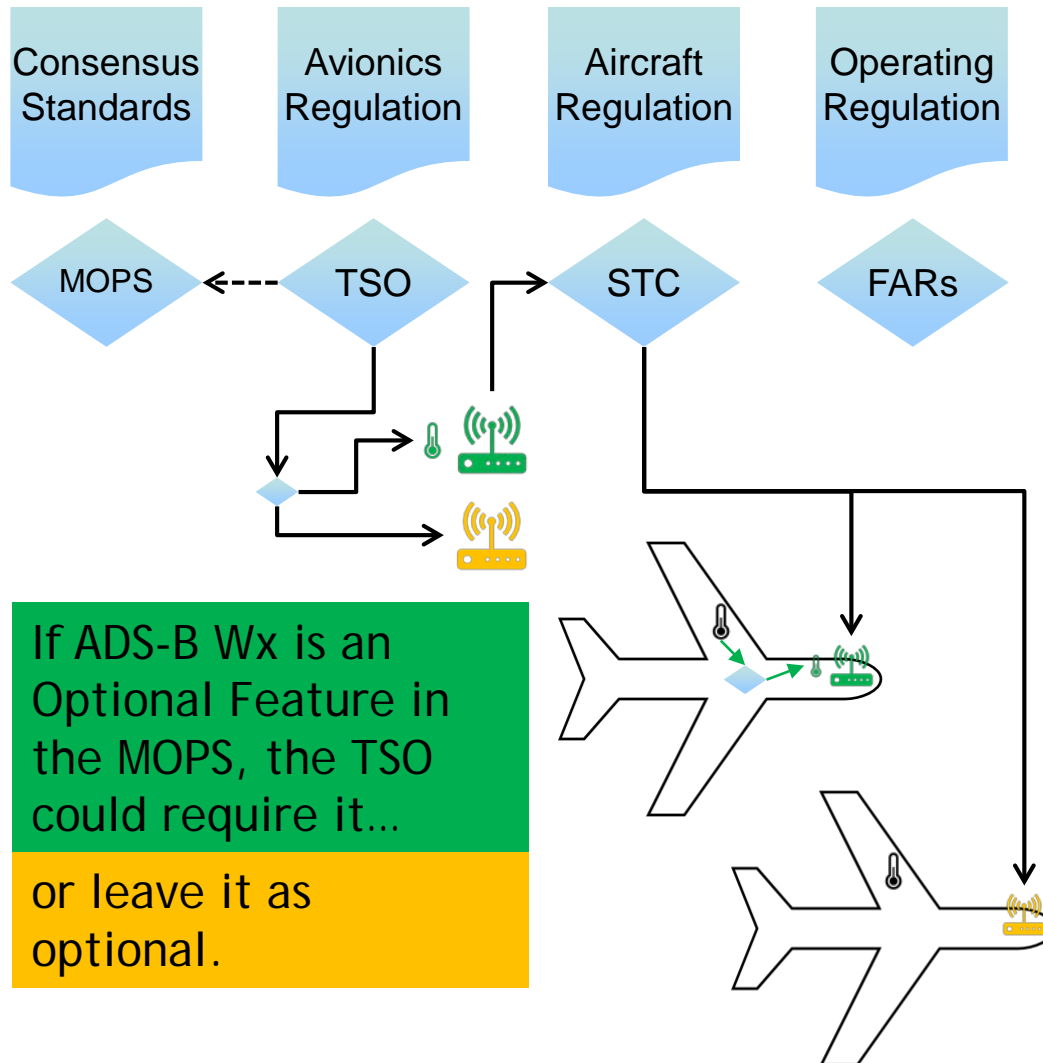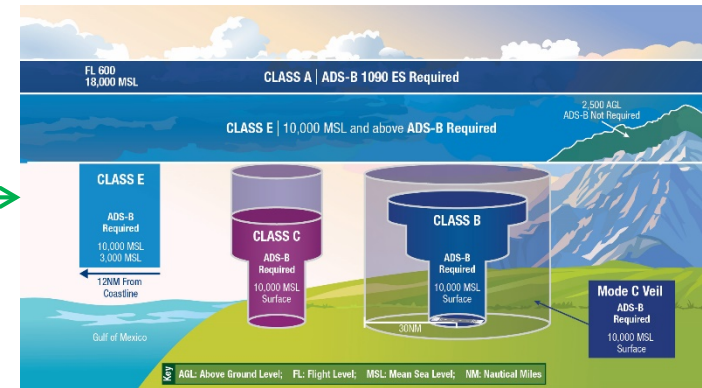
- Multiple approaches can achieve signal-in-space.

If ADS-B Wx is an Optional Feature in the MOPS, the TSO could require it…

or leave it as optional.

Specifying ADS-B Wx as optional could result in a generation of transponders without ADS-B Wx, leaving interested operators unable to equip and delaying benefits for a generation.
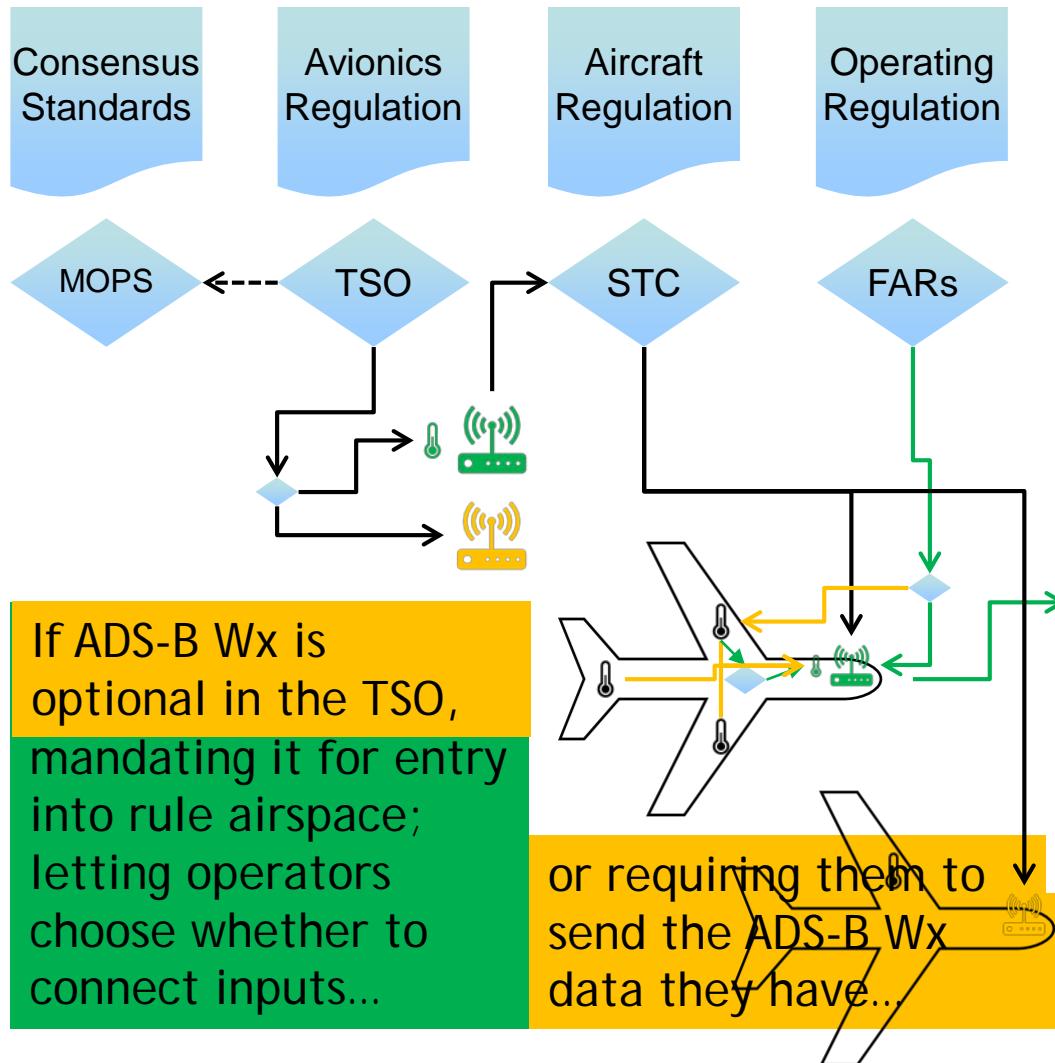
Ensuring Signal-in-Space

- Multiple approaches can achieve signal-in-space.
- Operator and/or airspace regulations can influence both avionics functionality and equipage.

Consensus Standards | Avionics Regulation | Aircraft Regulation | Operating Regulation

MOPS ← TSO → STC   FARs

If ADS-B Wx is optional in the TSO, mandating it for entry into rule airspace; letting operators choose whether to connect inputs…

or requiring them to send the ADS-B Wx data they have… or to equip to send all ADS-B Wx data.

NATIVE FUNCTION vs. OPTIONAL FEATURE?

Native Function

- Compliance with MOPS would require implementation of ADS-B Wx functionality

  – Messages that include ADS-B Wx parameters would be implemented for all ADS-B V3 products not seeking exception for ADS-B Wx function

Optional Feature

- Compliance with MOPS would not require implementation of ADS-B Wx functionality

  – Messages that include ADS-B Wx parameters would only be implemented by manufacturers wishing to add ADS-B Wx feature to ADS-B V3 products

1. **Should ADS-B Wx be specified as a native function or optional feature in the MOPS?**
   - Giving operators choice on connecting inputs supporting ADS-B Wx messages

2. **Should ADS-B Wx be specified as required for TSO compliance?**
   - Giving operators choice on connecting inputs supporting ADS-B Wx messages

3. **Should ADS-B Wx be mandated for entry into rule airspace?**
   a. For available information from installed systems, e.g. pressure, temperature, wind?
   b. For all ADS-B Wx data, including those requiring equipage, e.g. EDR and Water Vapor?

Reasons for Native Function

- Criticality of ABO to aviation forecasts and forecast model performance

- Improved routine weather surveillance

- Improved hazardous weather and wake turbulence prediction and avoidance

- Improved cruise and terminal operations

- Support from native function to ADS-B Wx mandate has been received

Reasons for Optional Feature

- Manufacturer costs to implement native function in avionics that may not be enabled by some

- FAA costs to process exceptions to native function if avionics manufacturers choose not to implement capability

- ADS-B V3 is not expected to be mandated for ADS-B Rule compliance (V2 required)

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QUESTIONS