

# ADS-B Weather Update

Presented to: Friends and Partners in Aviation Weather

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Date: 18 May 2023



**Federal Aviation  
Administration**

# Q. Why ADS-B Wx?

## A. Aviation Safety, Efficiency, and Utility...

### AIREP (Air Reports) Benefits

More rapid, more accurate weather awareness

More accurate, precise, and frequent forecasts & nowcasts

More efficient aircraft operations

Improved awareness & avoidance of adverse and hazardous weather and hazardous wake turbulence

Better access to more ABO data

Increased aircraft utility

### PIREP (Pilot Reports) Benefits

More effective pilot decisions

AIREP impacts where PIREPs are submitted

More PIREPs with fewer errors

Relieve ATC/FSS collection and transcription by fully automating:  
PIREP data submission  
Encoded PIREP creation

ADS-B PIREP dissemination via existing networks, including FIS-B

Increased aircraft utility

Automated wake encounter reporting

# Q. Why ADS-B Wx?

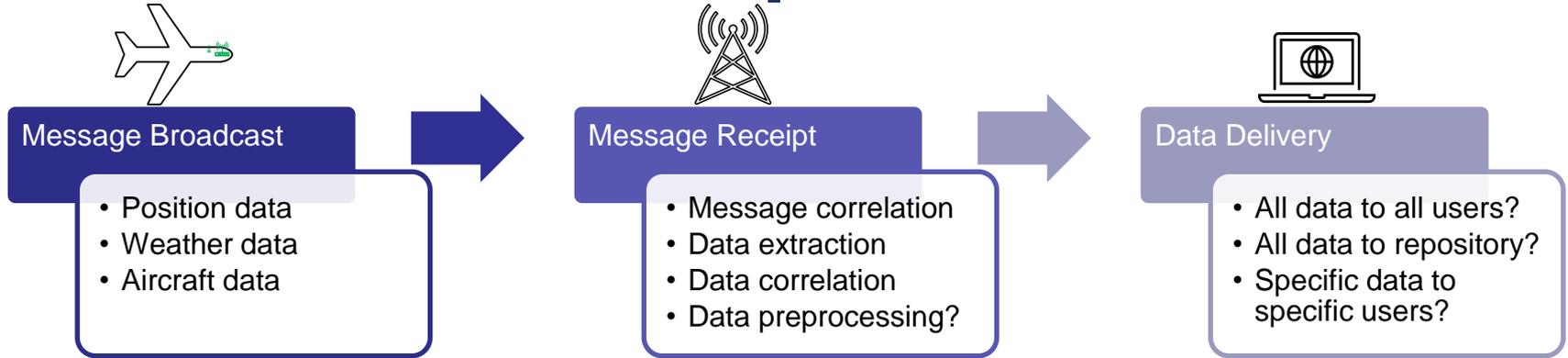
## A. Impacts Beyond Aviation...

**“Every year, weather variability is estimated to cost \$630 billion for the U.S. alone, or 3.5% of GDP.”** Harvard Business Review, 2017

**“Climate change and extreme weather events ... have a direct impact on 70% of all economic sectors worldwide.”** Forbes on Deloitte’s 2021 Climate Check Survey

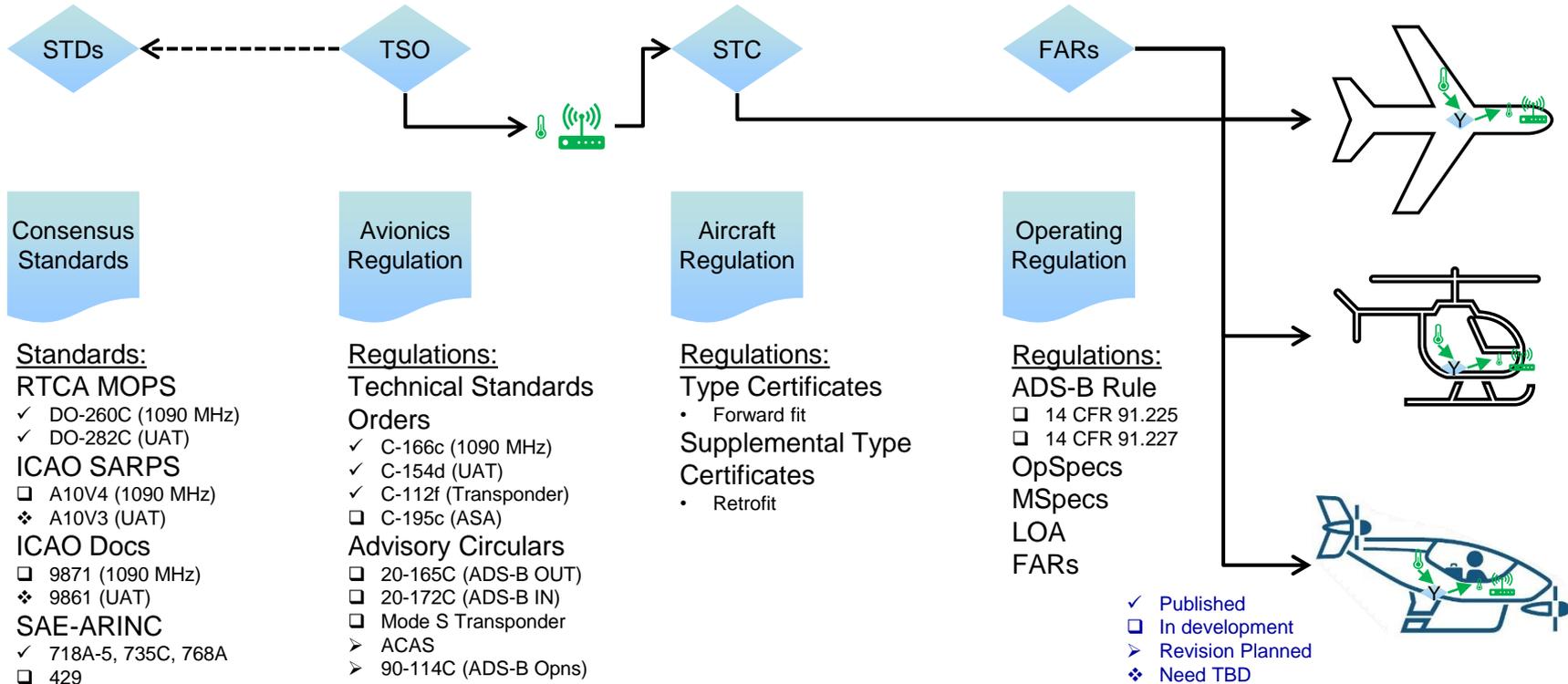
- **Extreme weather plagues the nation, with the economic cost of severe weather events in 2022 totaling a staggering \$165 billion**
  - Nine, billion-dollar disasters impacted the U.S. in 2022
- **The start of 2023 has seen incredible precipitation and flooding events on both the East and West coasts**

# ADS-B Wx Development



- **Ensuring stakeholders are involved in the message broadcast, receipt, and data delivery planning**
  - Specific uses considered; e.g., flight deck applications and ground-based decision support tools need data in real time, climatology can work from historical archives

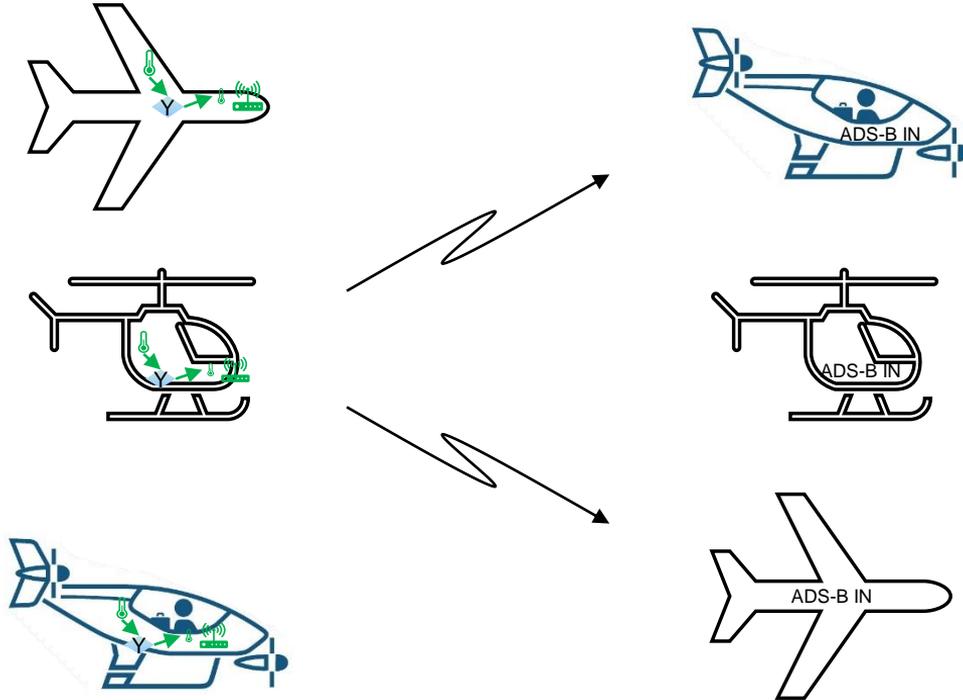
# Progress towards Signal-in-Space



# ADS-B Wx Requirements Support

- **NTSB recommended to the FAA that ADS-B Wx requirements be incorporated into the TSOs for ADS-B V3 avionics and that Part 121 air carriers be required to equip with and operate ADS-B Wx capable avionics in ADS-B rule airspace**
- **The ADS-B Wx capabilities are specified in the RTCA/EUROCAE Minimum Operational Performance Standards (MOPS) as optional capabilities**
  - During the public comment period for the ADS-B V3 TSOs (C-166c and C-154d) the following organizations recommended that ADS-B Wx be specified as a native function
    - WMO, NWS, AWC
    - ALPA, United Airlines
    - FAA Wake CSTA, Dynamic Aerospace
- **FAA did not accept these recommendations, indicating that a rule requiring ADS-B Wx capable avionics installation and operation could be supported by optional requirements**
  - The ADS-B Rule is being modified to allow the use of either V2 or V3 avionics for rule compliance. A public comment period will allow recommendations to be made to require ADS-B Wx for operations in rule airspace.

# Progress towards Air-to-Air Receipt



## Consensus Standards

### Standards:

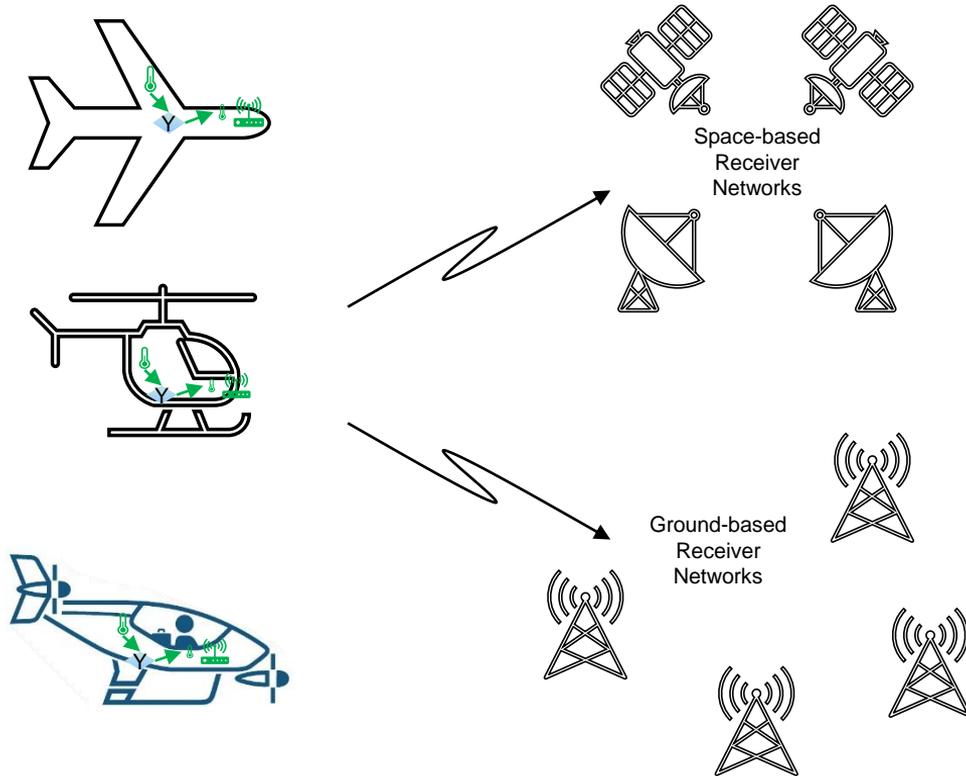
- RTCA MOPS
  - ❖ DO-317 (ASA)
  - ✓ DO-361 (FIM)
- ICAO SARPS
  - ☐ A10V4 (1090 MHz)
  - ❖ A10V3 (UAT)
- ICAO Docs
  - ☐ 9924 (Aero Surv)
  - ❖ 9994 (Airb Surv)

## Operating Regulation

### Regulations:

- OpSpecs
  - MSpecs
  - LOA
  - FARs
- 
- ✓ Published
  - ☐ In development
  - Revision Planned
  - ❖ Need TBD

# Progress towards Air-to-Ground Receipt



## Consensus Standards

### Standards:

ICAO SARPS

- ❑ A10V4 (1090 MHz)
- ❖ A10V3 (UAT)

ICAO Docs

- ❖ 8071 Vol III
- ❑ 9924 (Aero Surv)
- ❖ 9994 (Airb Surv)

EUROCAE

- ❑ ED-129C/D (Rcvr Sys)

## Receiver Specs

### Specifications:

SBS Program Office

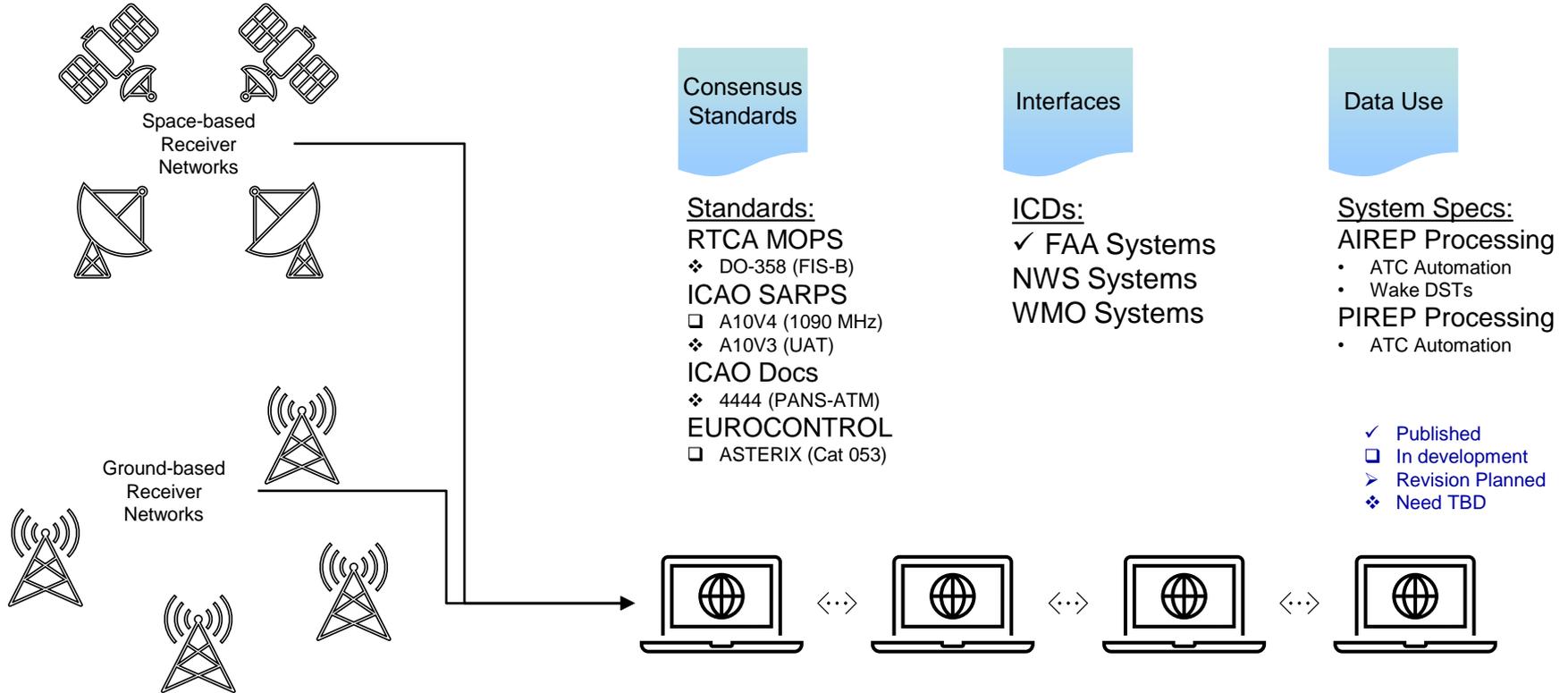
Performance-based

Specifications

- 1090 MHz
- UAT

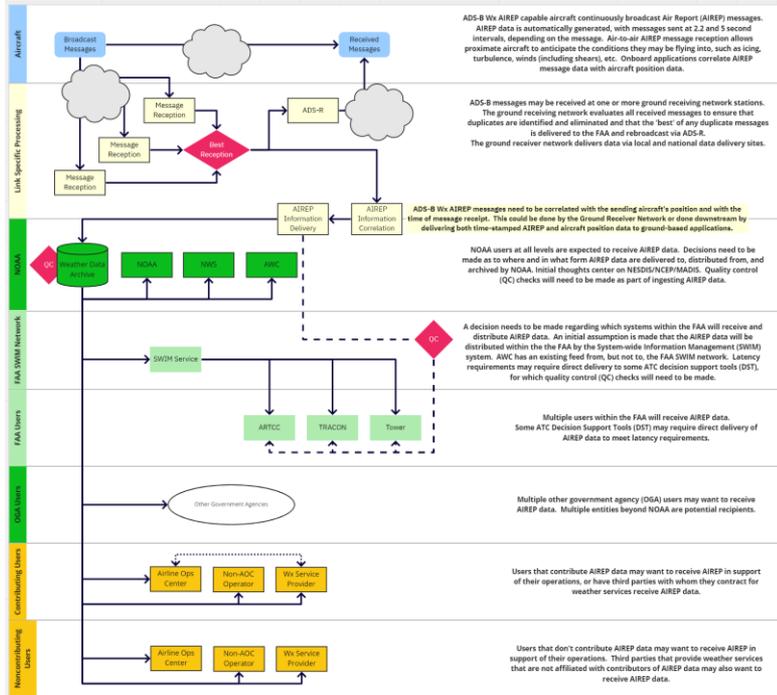
- ✓ Published
- ❑ In development
- Revision Planned
- ❖ Need TBD

# Progress towards Data Delivery

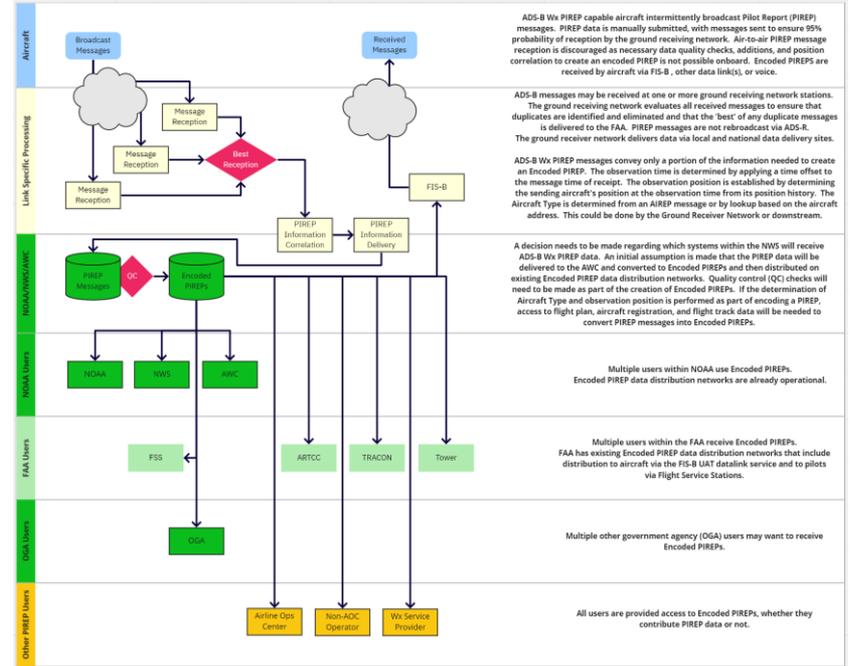


# ADS-B Wx Data Flow Concepts

## AIREP



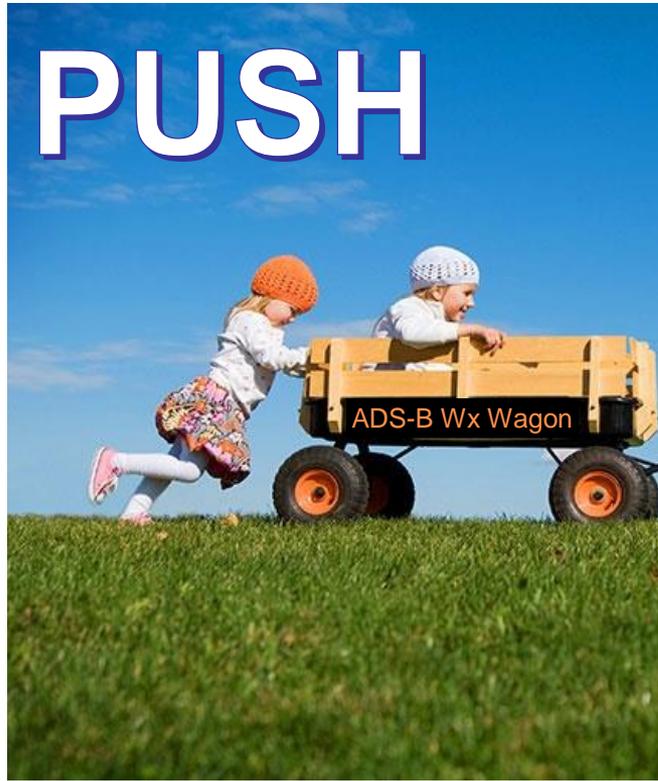
## PIREP



# ADS-B Wx Development Next Steps

- **Needed capabilities in development:**
  - ADS-B V3 transponders sending ADS-B Wx messages
- **Ground distribution capabilities for ADS-B Wx information**
  - Upgrade of SBS network to receive and distribute ADS-B V3 messages approved
  - ADS-B Wx data distribution ConOps development and coordination has begun
  - ICAO and WMO requirements for AbO communications and sharing are established
  - ASTERIX categories are being defined to carry ADS-B Wx parameters
  - Specifications for ADS-Wx PIREP Message transcoding to Encoded PIREP format are needed
  - Segmented and end-to-end system testing and monitoring capability is needed
- **Integration into forecast and air traffic systems needs to be planned and implemented**
- **Continuing coordination with:**
  - Weather community (NOAA/NWS/AWC, FAA, WMO, FPAW, AMS)
  - Other standards bodies and regulators (EUROCAE, EUROCONTROL, FAA, ICAO)
  - Manufacturers and Operators

# How We Got This Far...



# What We Need...



# What We're Proposing...

## ... an ADS-B Wx Pilot Program

### Objectives

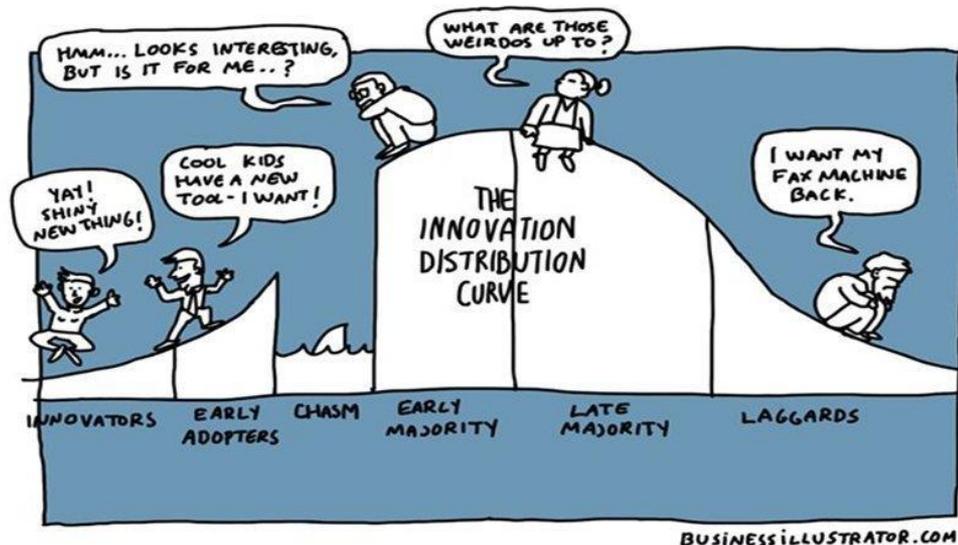
- Demonstrate the benefits of incorporating ADS-B Wx Air Report (AIREP) data into numerical weather prediction (NWP) models
- Demonstrate the incorporation of ADS-B Wx AIREP data into air traffic systems
- Demonstrate air-to-air receipt of ADS-B Wx AIREP data for flight deck applications
- Demonstrate the benefits of incorporating ADS-B Wx Pilot Report (PIREP) data into weather forecasting and air traffic systems

### Execution

- **Three to five-year, \$8M-\$12M plan**
- **Equip aircraft with ADS-B Wx**
  - 150 aircraft operated nationally in a commercial fleet
  - 50 aircraft operated in a region of meteorological interest
  - 25 UAS conducting routine, gap-filling weather observations
- **Receive and distribute ADS-B Wx AIREP & PIREP data to users**
- **Publish results to inform ADS-B Wx implementation decisions**

# Help Pull the ADS-B Wx Wagon!

- Support the ADS-B Wx Pilot Program proposal
- Be a vocal Innovator or Early Adopter
  - If you can't, commit to being in the Early Majority



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# Discussion



# Backup Charts



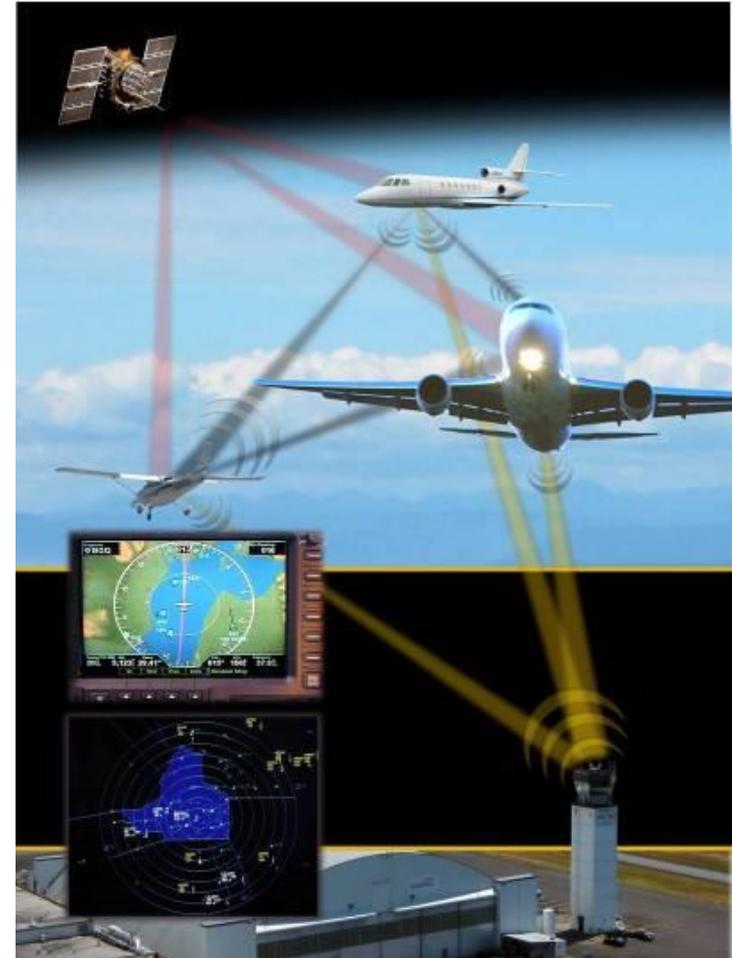
# ADS-B Overview

- **Automatic**
  - Periodically transmits information with no pilot or operator input required
- **Dependent**
  - Position and velocity vector are derived from the Global Positioning System (GPS)
- **Surveillance**
  - A method of determining position of aircraft, vehicles, or other asset
- **Broadcast**
  - Transmitted information available to anyone with the appropriate receiving equipment



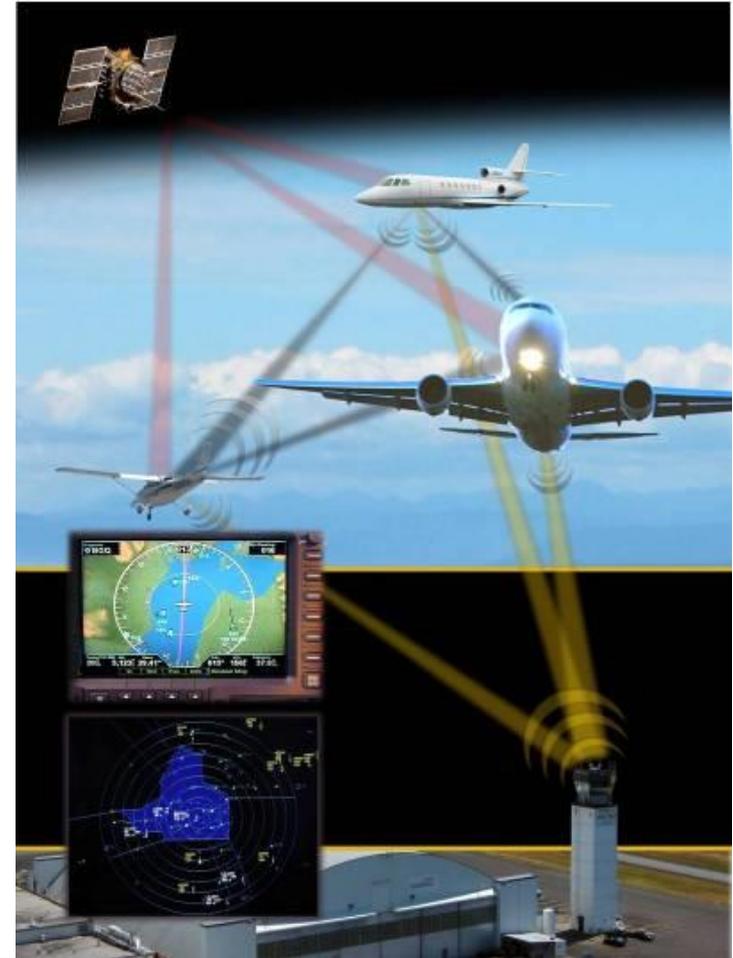
# ADS-B Wx AIREP Overview

- **Automatic (Continuous)**
  - Periodically transmits Air Report (AIREP) information with no pilot or operator input required
- **Dependent**
  - AIREP information derived from onboard sensors and systems
  - Position derived from GNSS and onboard altimetry
- **Surveillance**
  - A method of continuously determining in situ atmospheric conditions in real-time
- **Broadcast**
  - AIREP information available to anyone with the appropriate receiving equipment



# ADS-B Wx PIREP Overview

- **Automatic (On-condition)**
  - Pilot-initiated, automatic transmission of Pilot Report (PIREP) information
- **Dependent**
  - PIREP location derived from historical aircraft track and PIREP time
  - PIREP data may be manually entered or derived from sensors and systems onboard the aircraft
- **Surveillance**
  - A method of rapidly providing pilot observed weather conditions
- **Broadcast**
  - PIREP message data intended for ground-based processing



# AIREP Parameters: 1090ES Messages

	Weather State Message 2.2 [s] Broadcast Interval	Alternate Weather State Message 2.2 [s] Broadcast Interval	Emergency/Priority Status Message 5.0 [s] Broadcast interval	Aircraft State Message 5.0 [s] Broadcast Interval
1	Icing Status	Icing Status (EHS Optional)	Mean EDR	Aircraft Configuration
2	Wind Quality Indicator	Roll Angle	Peak EDR	Aircraft Type
3	Wind Speed	Heading Type	Peak EDR Offset	Gross Weight
4	Wind Direction	Heading	Water Vapor	Wingspan
5	Air Temperature Type	Air Temperature Type		
6	Air Temperature	Air Temperature		
7	Airspeed Type	Airspeed Type		
8	Airspeed	Airspeed		

- **Only those parameters that the aircraft is equipped to send are sent**
- **There is no requirement for aircraft to equip to send all parameters**

# AIREP Parameters: UAT Payload Element Subtypes

	Wind and Turbulence Message 12 [s] Broadcast Interval	Water Temperature and ARV Message 12 [s] Broadcast Interval	Aircraft State Message 12 [s] Broadcast Interval
1	Wind Quality Indicator	Icing Status	Aircraft Configuration
2	Wind Speed	Air Temperature Type	Aircraft Type
3	Wind Direction	Air Temperature	Gross Weight
4	Mean EDR	Airspeed Type	Wingspan
5	Peak EDR	Airspeed	
6	Peak EDR Offset	Water Vapor	
7	Roll Angle	Heading Type	
8	Airspeed	Heading	

- **Only those parameters that the aircraft is equipped to send are sent**
- **There is no requirement for aircraft to equip to send all parameters**

# PIREP Parameters: 1090ES Messages (PIREP Data, not an Encoded PIREP)

	Flight Weather Message On-condition Broadcast	Temp, Wind & Turbulence Message On-condition Broadcast	Hazardous Weather Message On-condition Broadcast
1	PIREP Time	PIREP Air Temperature	PIREP Icing
2	Flight Visibility	PIREP Air Temperature Type	Airspeed Change
3	Flight Weather 1	PIREP Wind Direction	Wind Shear Height
4	Flight Weather 2	PIREP Wind Speed	Braking Action
5	Flight Weather 3	Turbulence Duration	Runway Number
6	Layer 'A' Height	Turbulence Intensity	Runway Position
7	Layer 'A' Thickness	Turbulence Location	Layer 'C' Height
8	Layer 'A' Height Type	Layer 'B' Height	Layer 'C' Thickness
9	Layer 'A' Coverage	Layer 'B' Thickness	Layer 'C' Height Type
10		Layer 'B' Height Type	Layer 'C' Coverage
11		Layer 'B' Coverage	Flight Weather 1 Vicinity Direction
12			Flight Weather 2 Vicinity Direction
13			Turbulence Type

- **Only those parameters that the pilot chooses to send are sent, there is no requirement to send every parameter**

# PIREP Parameters: UAT PIREP Payload Frame (PIREP Data, not an Encoded PIREP)

PIREP Payload Frame On-condition Broadcast			
1	PIREP Time	PIREP Wind Direction	Wind Shear Height
2	Flight Visibility	PIREP Wind Speed	Braking Action
3	Flight Weather 1	Turbulence Duration	Runway Number
4	Flight Weather 2	Turbulence Intensity	Runway Position
5	Flight Weather 3	Turbulence Location	Layer 'C' Height
6	Layer 'A' Height	Layer 'B' Height	Layer 'C' Thickness
7	Layer 'A' Thickness	Layer 'B' Thickness	Layer 'C' Height Type
8	Layer 'A' Height Type	Layer 'B' Height Type	Layer 'C' Coverage
9	Layer 'A' Coverage	Layer 'B' Coverage	Flight Weather 1 Vicinity Direction
10	PIREP Air Temperature	PIREP Icing	Flight Weather 2 Vicinity Direction
11	PIREP Air Temperature Type	Airspeed Change	Turbulence Type

- **Only those parameters that the pilot chooses to send are sent, there is no requirement to send every parameter**