

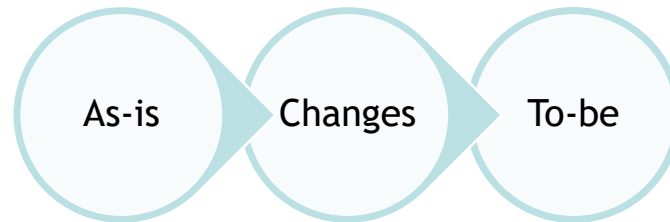


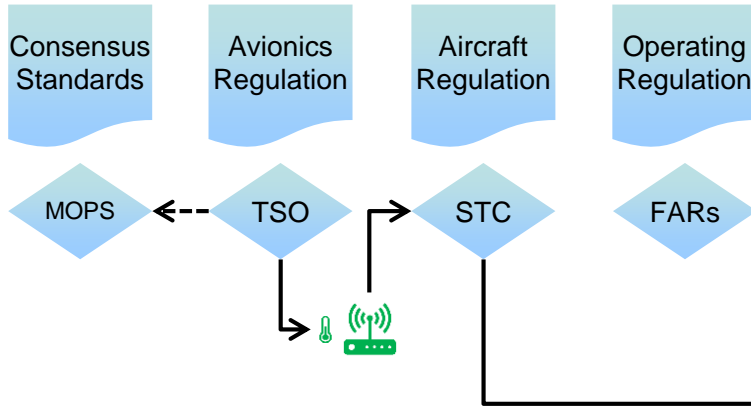
ADS-B Weather Data Distribution Planning

Friends and Partners in Aviation Weather
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- Update ADS-B Wx development status
- Use the unique gathering by FPAW of aviation weather researchers, providers, users, and regulators, to provide input to the ADS-B Weather data distribution concept of operations and planning

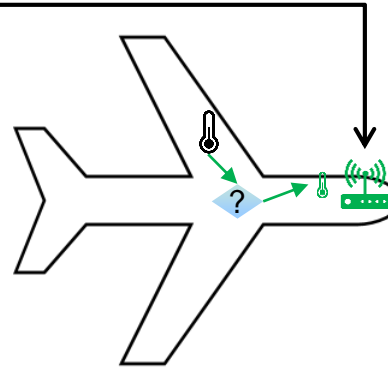




ADS-B Wx provides for:

- 1) AIREP: Fully-automated, high-rate, periodic broadcast of aircraft-based observations (Air Reports)
- 2) PIREP: ADS-B data link submittal of pilot-observed weather information

ADS-B Wx is specified as optional in ADS-B V3. Operators are free to choose whether to equip and which ADS-B Wx inputs to connect. No ADS-B V3 or Wx mandate is anticipated.



ADS-B Wx will be enabled on the basis of avionics and aircraft standards and regulations, and the interests of operators.

AIREP

- Air traffic control procedures whose performance is limited by lack of real-time weather information
 - Controllers apply buffers and continuously adjust headings and airspeeds to achieve spacing and maintain separation, limiting operating efficiencies
 - Wake separation and trajectory-based procedures that are conservative and unable to be optimized
- Weather forecast models whose performance is most dependent on aircraft-based observations

PIREP

- A submission and dissemination system, primarily dependent on voice communications and manual data processing, that is subject to delays, errors, and data losses that can play a role in aircraft accidents

AIREP

- Real-time, in-situ, sensed/derived aircraft-based observations available to:
 - Air Traffic Control decision support tools
 - Air Traffic Management decision support tools
 - Weather forecast models
 - Aircraft operations centers
 - Air-to-air applications
 - Weather data archives

PIREP

- Pilot data entry with in-app error checking
- Immediate, automated submission
- Immediate, automated, error-checked data processing and PIREP encoding
- Immediate, automated dissemination via existing PIREP networks, including FIS-B

AIREP Impacts

- More accurate, more precise, more frequent forecasts
- More rapid, more accurate weather awareness
- Improved avoidance of hazardous weather
- More efficient aircraft operations
- Improved avoidance of hazardous wake turbulence

PIREP Impacts

- More PIREPs with fewer errors
- ATC/FSS-independent, fully automated:
 - PIREP data submission
 - PIREP encoding
- Continued PIREP dissemination via existing networks
- Many AIREP impacts where PIREPs are submitted

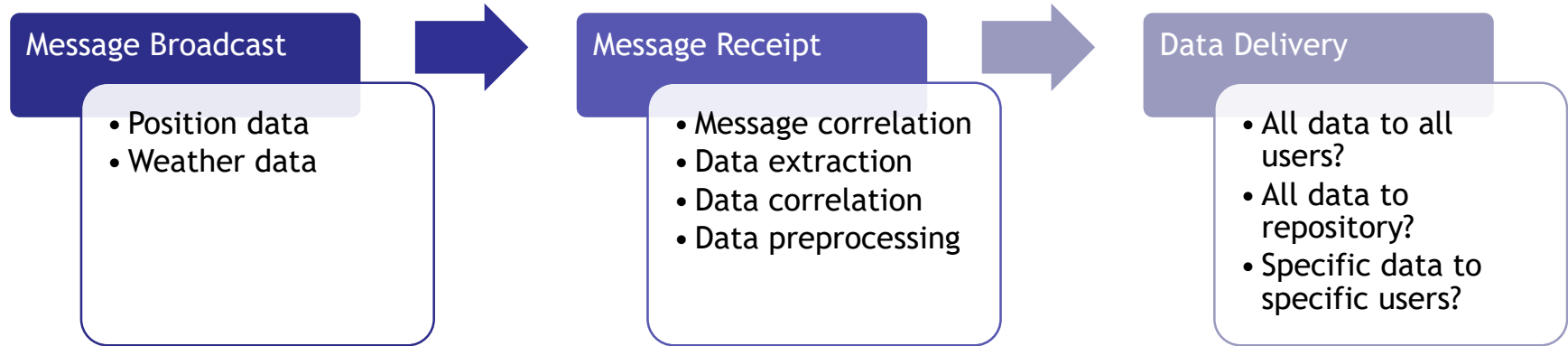
Complete or Planned/Pending

- ADS-B Wx messages are defined for broadcast in ADS-B V3
- ADS-B V3 avionics will be available in the coming years
- The FAA is planning to upgrade the ADS-B ground receiver network to receive and decode ADS-B Wx messages

Needed

- Scope and specify the ground-based delivery of the ADS-B Wx data
 - Which data? In what form?
 - To where / whom?
 - When? (Continuously? On-Condition?)
 - How? (Thru what communications channels using which protocols?)

HOW DO WE ACHIEVE THE ‘TO-BE’?



- Specific uses must be considered; e.g. wake turbulence decision support tools need data in real time, climatology can work from historical archive(s)
- We want to gather input from FPAW participants to further our ConOps development

- Air Traffic Control and Management
 - 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
 - Wake Encounter Reporting (with ADS-B PIREP)
- Weather Forecasting ¹
 - Rapid-update observations enabling rapid-update forecasts
 - Forecast validation
 - Forecast skill improvements
 - NWP model performance improvements
 - Improved hazardous weather detection and prediction
 - Forecast feature-size reductions, e.g. icing, turbulence

¹ Ground-based

² Flight Deck-based



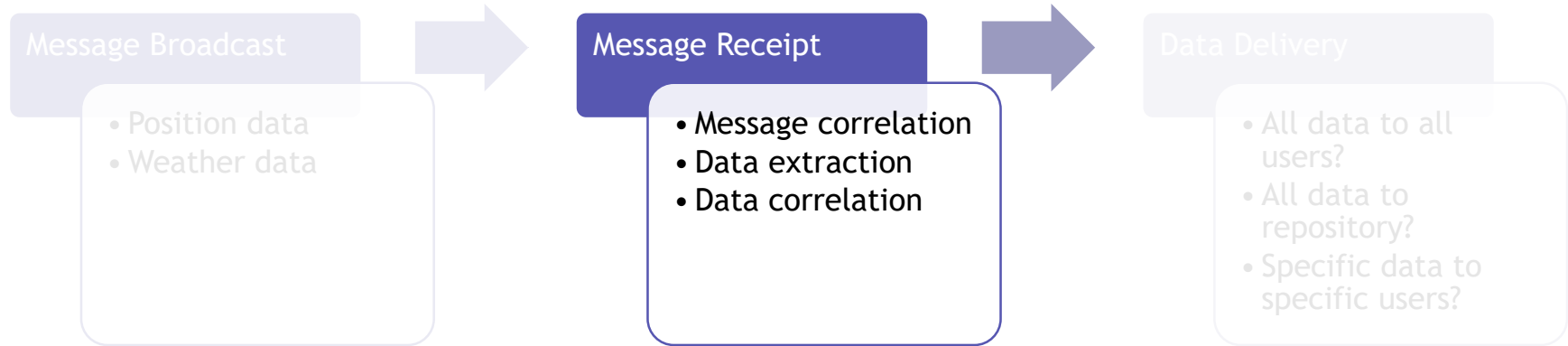
- Message Broadcast is fully specified for both AIREP and PIREP
 - ADS-B Wx messages don't include location information
 - ADS-B messages don't include time information
- Knowing where and when weather was observed is important

	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		

- ADS-B Wx capable systems broadcast Weather State or Alternate Weather State message based on dynamically determined validity of Wind Speed and Wind Direction
- EHS capable transponders, not implementing ADS-Wx AIREP, broadcast the Alternate Weather State Message to meet European Enhanced Surveillance (EHS) requirements

PIREP Parameters: By Message Data, not Information

	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



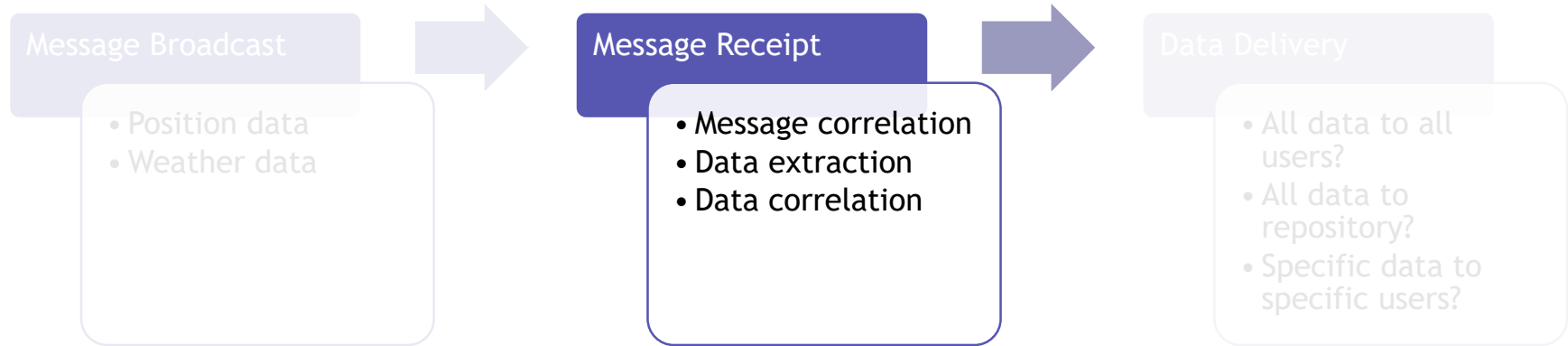
- Ground receiver network update is planned
- Ground-receiver network data processing must be specified

ADS-B Position Parameter	AIREP Data Correlation Approach
UNIQUE AIRCRAFT IDENTIFIER	ICAO 24-bit address in all Mode S/ ADS messages is used to correlate ADS-Wx parameters across messages
LATITUDE	Correlate AIREP data with position from ADS-B Position Messages
LONGITUDE	
PRESSURE ALTITUDE	Correlate AIREP data with position from ADS-B Barometric and/or GNSS Altitude
DATE DAY	Rely on receiver function to assign time of applicability to received messages. If application needs longer scale time, it must provide conversion.
TIME	
GNSS ALTITUDE	GNSS altitude difference from barometric altitude is always available in ADS-B V3

- AIREP data must be correlated across multiple messages

Encoded PIREP (information) creation from ADS-B Wx PIREP Messages (data)

Item	Element (Code)	Contents	ADS-B Wx PIREP Message Source
1	3-letter station identifier (XXX)	Nearest weather reporting location to the reported phenomenon	Assigned by ground-based data processing
2	Report type (/UA UUA)	Routine or Urgent PIREP	
3	Location (/OV)	Lat/Long, or in relation to a VOR	Determined on ground from Track, based on Time
5	Altitude (/FL)	Essential for turbulence and icing reports	
4	Time (/TM)	Coordinated Universal Time	Translated on ground from PIREP Time in Flight Weather Message
6	Type Aircraft (/TP)	Essential for turbulence and icing report interpretation	Direct: Aircraft State Message Indirect: ICAO 24-Bit Address, Flight Plan, Aircraft Registration
7	Sky cover (/SK)	Cloud height and coverage (sky clear, few, scattered, broken, or overcast)	Flight Weather Message
8	Weather (/WX)	Flight visibility, precipitation, restrictions to visibility, etc.	Flight Weather Message
9	Temperature (/TA)	Degrees Celsius	Temp, Wind & Turbulence Message
10	Wind (/WV)	Direction in degrees magnetic north and speed in knots	Temp, Wind & Turbulence Message
11	Turbulence (/TB)	Intensity, Duration, Location, Type	Temp, Wind & Turbulence Message
12	Icing (/IC)	Type and Intensity	Hazardous Weather Message
13	Remarks (/RM)	For reporting elements not included or to clarify previously reported items	Required Condition Remarks, Wind Shear, Braking Action, Mountain Wave Encounter, Volcanic Odor



- Extent of data processing on receipt vs. downstream?
- What data regarding the observing aircraft is required?
 - To interpret the data?
 - To perform QC on the data?



- Ground-based data delivery must be specified
 - To whom?
 - How fast?
 - Redundancy?
 - Resilience?
 - How much data?



- ADS-B Wx data ground distribution format(s) and channels must be defined
 - ASTERIX Weather Surveillance (WxS) Message?
 - SWIM WxS message?
 - DST-specific formats and communications channels?
 - AOC and Wx service providers formats and communications channels?

Contact Info

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**HELP US HELP YOU BY GETTING
INVOLVED!**