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## CURRENT SITUATION & DEFICIENCIES

Operations currently rely on two basic types of weather information:

- Real time detection, on-board, by means of a Weather Radar
- Weather forecasts and observations, distributed as ICAO Annex 3 products (TAF, METAR, TEMSI, Winds Aloft, ... etc)

Traditional ICAO Annex 3 products are limited in their information, representation and have long intervals between their distribution cycle compared to the evolution of phenomena. Moreover they are not appropriate to modern digital and graphical representations.

Aircraft weather radar is real-time detection, primarily of water vapor / ice precipitation with a volumetric limit to a forward sector of view. Although some products have long ranges of several hundred of Nm, the real-time detection cannot provide strategic evolution of the phenomena. Then weather radar is suitable for short term safety helping pilots for tactical decisions. On contrary, it is not adapted for long term safety and strategic rerouting.

## THE NEED FOR SAFE OPERATIONS

Flight incidents and accidents clearly show that the basic weather information currently available in cockpits is not sufficient neither to improve flight safety nor to strategically integrate the forecast situation in the operation of a flight. A high proportion of dangerous weather situations are caused by dangerous air mass movements (e.g. Clear Air Turbulence, Wind shear, Dry convection). More intense phenomena due to global warming and are expected in the future, the danger generated by such phenomena will increase.

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For these reasons, basic weather information currently available in cockpits should be enhanced with following additional and non-exhaustive information related to in flight weather:

- Convection
- Clear Air Turbulence (CAT)
- Icing
- Turbulence
- Volcanic ash cloud

And ground / airport weather:

- Wind
- Ceiling
- Visibility/RVR
- Temperature
- Windshear
- Pressure
- Runway contamination.

Complementary weather data could be used for performance assessment and global weather analysis, including a non-exhaustive list of parameters such as wind and temperature, tropopause, jet streams, Iso 0°, miscellaneous TAF/METAR weather data, satellite IR...

With this additional information, operators are also expecting:

- End-to-end solutions including embedded systems but also associated services,
- Aeronautical weather data with higher refresh rates, in particular for forecast weather along the flight plan and at destination airport
- Consistent weather information on-board, on AOC and ATC for strategic rerouting purpose,
- Adequate weather information and geographical coverage regarding their fleet and flight operations,
- Best use of modern representation technologies (color screen, selection methods, 3D flight time vision),
- Access to wider variety of weather products (satellite imagery),

All these needs are expressed by pilots and correspond to a real expectation.

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## AVAILABLE OPTIONS

Embedded weather radars improvements will not be sufficient to achieve these needs and several research programs related to weather information provided to pilots are analyzing additional solutions.

In the framework of SESAR (Single European Sky ATM research) THALES has conducted studies with airborne EFB based solutions associated with ground servers.

These activities are related to provision of weather information in aircraft for pilots situational awareness and operations optimization. The solutions provide the cockpit with:

- A weather 4D format on a graphical display (2D map, as well as vertical and time projections) that has been found useful to pilots for strategic decision making. These formats may also be used for navigation optimizations.
- Flight planned & alternative routes can also be superimposed on this display.
- The 4D format can be composed of classical ICAO Annex 3 products enhanced with a wide range of additional information (eg. CAT, convection, icing, wind including Jet streams, temperature, Significant phenomena as volcanic ash, sandstorms, ...)
- Weather information is constantly updated at the MET provider's refresh rate.

With the gains provided by this kind of solution, the weather radar range could be reduced and its use focused on shorter term view for which it is more adapted.

## ASSOCIATED CHALLENGES

### TECHNICAL

In the modern day situation where weather evolution data is available and distribution channels are available, the principal challenges are:

- To collect real-time weather data & its evolutions from ground based, satellite-based or on-board observations. Air Traffic management data link technologies (ADS-Contract) are already standardized to provide on-board generated observations (Turbulence, Wind, Temperature) automatically to ground systems. Other sensor based products exist (ex. AMDAR). The key progress point will be to rapidly process and redistribute the information.
- To redistribute appropriate data to the cockpit in order to provide crew with
  - o An up to date situation of the actual weather situation
  - o A prognosis of the weather evolution which can be projected

and using modern IT & graphical tools, along the flight path, vertically and in time, planned to be flown or on alternative route option

### REGULATION

Agency could contribute to facilitate and accelerate the deployment of such solutions by:

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- Proposing to amend ICAO Annex 3 to introduce new weather products
- Initiating rule making tasks to amend Air Operation rule (EU 965/2012) for introduction of new requirements or recommendations for the embedding of systems allowing providing enhanced near real-time weather information based on ground, in-situ and satellite data.
- Initiating rule making tasks to amend rule for Meteorological information providing service for air navigation (Part-MET Opinion 03-2014) for introduction of necessary organizational and technical requirements addressing real-time weather information distribution for use by embedded systems.

Regulation challenge is to set-up the adequate regulatory framework to take benefice from new weather information products and new IT technologies and promote safety continuum.

## STANDARDIZATION

As for aeronautical data (eg. Navigation data), weather data will need a minimum subset of data quality requirement to the meet the needs of the associated intended use, the challenge will be to fine tune the integrity/cost benefit.

Weather information transmission will have to be standardized, as for instance PIREP messages from on-board to ground for broadcast purpose.

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