UFO

ULTRA FAST WIND SENSORS

New generation operational multifunction x-band and 1.5 µm lidar sensors for wind hazards monitoring on airport

THALES DLR KNMI Leosphere NLR DWD ONERA Technische Universität Braunschweig

UCL Université catholique de Louvain UPMC Sorbonne Universités TU Delft Flughafen München METEO FRANCE Toujours un temps d'avance ISL EUROCONTROL dgac STAC

SEVENTH FRAMEWORK PROGRAMME

European Commission

- **WP1000:** Advanced Sensors Technology Study
- **WP2000:** Processing, Modeling and Design tools development for sensors
- **WP3000:** Data Fusion and Resource Management
- **WP4000:** Field Test and Validation
- **WP5000:** Requirements and Safety Case
- **WP6000:** Management

UFO PROJECT
SUMMARY

The UFO project aims at ensuring aviation safety at current high standards or even better, regardless of air transport growth, through Wake-Vortex Advisory Systems improvement, in connection with SESAR P12.2.2 project. UFO research works will address a wide range of innovative technologies through studies of new Ultra Fast Lidar/Radar Wind & EDR (Eddy Dissipation Rate for turbulence) monitoring sensors, usable for Wake-Vortex Hazards Mitigation, but also for severe Cross-Wind, Air Turbulence and Wind-Shear.

Constrained by high update rate and accuracy requirements needed for wind measurements, 2D electronic scanning antenna technology based on low cost tile will be explored for X-band radar through a development of a tile mock up as well as a new high power laser source of 1.5 micron Lidar 3D scanner with higher power.

In addition, new design tools will be developed through simulators, able to couple Atmosphere models with Electromagnetic, Radar and LIDAR models. In parallel, advanced Doppler signal processing algorithm will be developed and tested for 3D wind field and EDR monitoring, including the algorithm for the resources management of the different sensors. Comparison with already existing sensors as C band meteorological radar and S band ATC radar, but also ADS-B Downlink will be studied.

Calibration of the ground sensors (Lidar, X-band radar, C-band radar) with ADS-B Downlink of meteorological data and the simulators will be achieved through a set of experimental trials in Munich and Toulouse airports. In Toulouse, an aircraft equipped with airborne probes will enable in situ comparison.

WIND SHEAR OF CONVECTIVE STORM

CRITICAL AIRCRAFT ROLL ANGLE AT LOW ALTITUDE
IN CASE OF WIND HAZARDS ENCOUNTERS

WAKE-VORTEX HAZARDS

RATIONALE AND CONTEXT
OF UFO PROJECT

Adverse meteorological conditions and weather hazards have a tremendous impact on Air Traffic Control (ATC) with limitations of capacity, flexibility and safety. Impacts of weather on aviation are huge and are a main cause of delay (1/3 of all), extra fuel consumption and associated increase of Greenhouse emissions. The fuel savings by aircraft delay absorption impact significantly on new Green constraints, airline costs and airport revenues.

The **safety level** will be improved through better wind now-casting/forecasting, predicting and alerting for weather related hazards (such as **wake turbulence, wind-shear** and **clear air turbulence**).

Safety is especially important during taking off and landing phases, as aircraft are less easy to manoeuvre. Improving exploitation of meteorological information during flight critical phases of **aircraft guidance and navigation** would directly impact flight **safety**. **UFO project** will deal with **ultrafast wind and ambient air turbulence monitoring** (at high update rate: < 1 mn) with new emerging technology of:

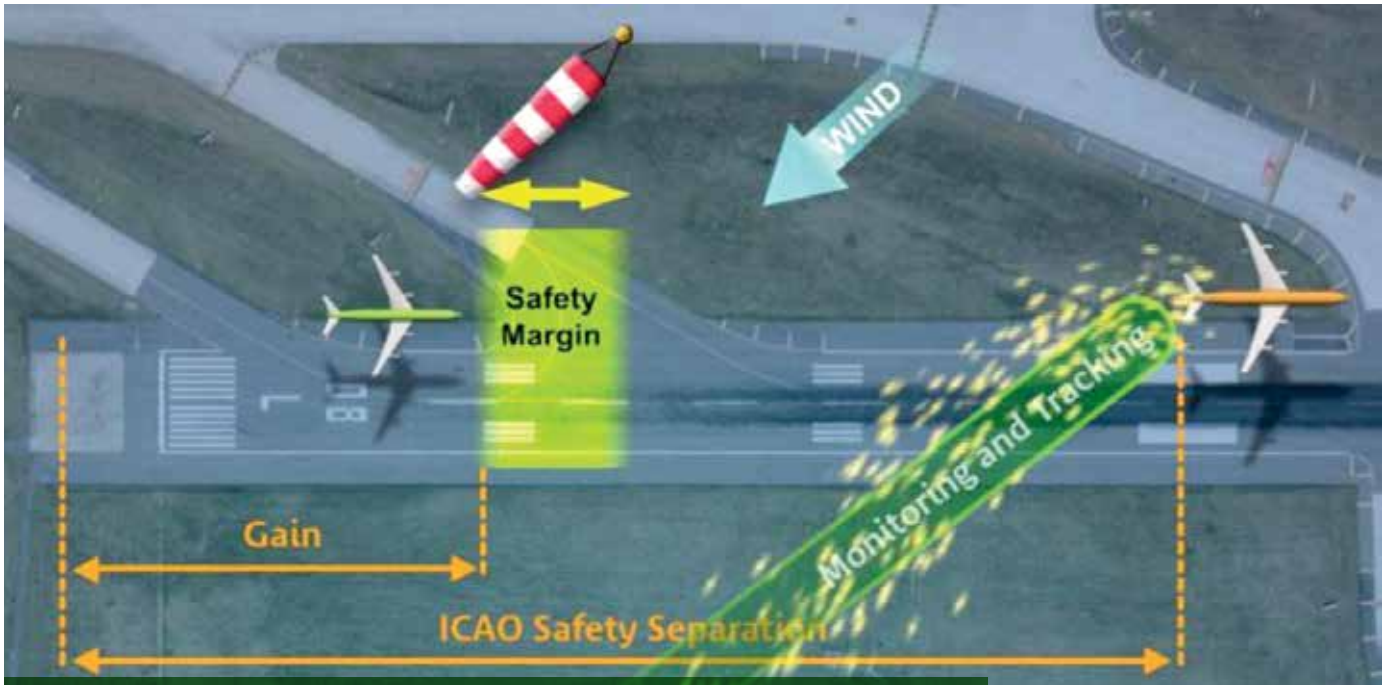
- 3D scanner Electronic Scanning X-band Radar/ high power laser 1.5 µm Lidar Sensors,
- Upgraded weather channel of ATC Primary Surveillance Radar,
- ADS-B Downlink of MET data from aircraft.

About **capacity**, currently at many airports, runway is the limiting factor for the overall throughput. Among the most important parameters are the **fixed wake turbulence separation** minima expressed in time for take-off clearance and by distance for arrivals on final approach. This limiting factor will be significantly accentuated soon with the arrival of new heavy aircrafts (Airbus A380, stretched version of Boeing B747-8) and very light jets. Existing departure and arrival wake turbulence separations are sometimes considered over conservative as they don't take into account meteorological conditions likely to shift, reduce or alleviate the wakes' circulations (measure of wake vortices strength).

More especially for wake-vortex, these hazardous flows usually dissipate quickly because of **decay due to air turbulence or transport by cross-wind**. However, for safety reasons, most airports assume a worst-case scenario and use conservative separations, which means the interval between aircraft taking off or landing often amounts to several minutes. However, with the **aid of fast-update/accurate wind data** and precise measurements of wake vortex, more efficient intervals can be set, particularly when weather conditions are stable. Depending on traffic volume, these adjustments can generate capacity gains, which have major commercial benefits.

SCIENTIFIC & TECHNOLOGICAL OBJECTIVES
UFO PROJECT

- **S&T1:** to design architecture of new generation low cost, light, highly reliable and high power X-band Radar antenna tile
- **S&T2:** to design, implement and test a new generation compact, low-cost 1.5 micron 3D Scanner wind lidar with high power laser source;
- **S&T3**: to define, develop and calibrate Radar/Lidar simulators dedicated for Wind/EDR Retrieval Capability;
- **S&T4:** to define, develop and test on real data new advanced and innovative high Doppler resolution processing for Wind and EDR retrieval;
- **S&T5:** to study collaborative/coordinated functioning of Lidar/Radar Sensors using their complementary performances/capabilities in wet/dry weather;
- **S&T6:** to define, simulate and test new ADS-B Broadcasting modes for Wind/EDR data downlink at high update rate with error compensation;
- **S&T7:** to define, develop and test on real PSR radar data new upgrade processing of ATC radar weather channel;
- **S&T8:** to develop and test during trials campaigns advanced Wind/EDR data fusion and assimilation in weather prediction model;
- **S&T9:** to perform Ultra Fast Wind Monitoring proof-of-concept at two different sites (Toulouse and Munich airports);
- **S&T10:** to perform a safety risk assessment and a safety case.



SAFE MARGIN GAIN REDUCTION OF AIRCRAFT WAKE-VORTEX SEPARATION BY ULTRA-FAST WIND AND WAKE-VORTEX MONITORING

New Generation Electronic-Scanning
Solid-State X-band Radar and High-Power Laser 3D
Scanner 1.5 µm Lidar (Toulouse Airport trials)

Operational X-band Radar
and 1.6 µm Lidar (Munich Airport)

Mode-S EHS and ADS-B Downlinks of MET Data
(Toulouse Airport Trials)

UFO CONSORTIUM
PARTNERS

INDUSTRIES

- **TR6:** Thales Air Systems (FR)
- **TSA:** Thales Systèmes Aéroportés (FR)

SME

- **LEO:** Leosphere SME (FR)

NATIONAL METEOROLOGICAL INSTITUTES

- **KNMI:** Royal Netherlands Meteorological Institute (NL)
- **DWD:** Deutscher Wetterdienst (GE)

EUROPEAN AERONAUTIC RESEARCH LABORATORIES

- **DLR:** Deutsches Zentrum fuer Luft und Raumfahrt (GE)
- **NLR:** National Aerospace Laboratory of the Netherlands (NL)
- **ONERA:** Office National d'Etudes et Recherches Aérospatiales (FR)

EUROPEAN ACADEMIC LABORATORIES

- **TUBS:** Technische Universitaet Braunschweig (GE)
- **UCL:** Université catholique de Louvain (B)
- **TUD:** Delft University of Technology (NL)
- **UPMC:** Université Paris 6 Pierre et Marie Curie, labo LATMOS (Institut Pierre Simon Laplace) (FR)

UFO PROJECT
DETAILS

- EU Programme: FP7 Transport – Aeronautics and Air Transport (AAT)
- EU Activity: Ensuring customer satisfaction and safety (7.1.3)
- EU Area: Aircraft safety (7.1.3.3)
- EU Sub-Programme Area: Systems and Equipments (AAT.2012.3.3-2.)
- DG: Research & Innovation, Aeronautics
- Contract Type: Small or medium-scale focused research projects
- Total Cost: 6276,563 k€
- EU Contribution: 4463,215 k€
- Grant Agreement: ACP2-GA-2012-314237-UFO
- Starting Date: 01 November 2012
- Duration: 36 months

UFO ASSOCIATED
PARTNERS

- **ERC:** EUROCONTROL (EU)
- **MA:** Munich Airport (GE)
- **MF:** Météo-France (FR)
- **STAC:** Civil Aviation Technical Centre (FR)
- **ISL:** Institut Saint-Louis (FR/GE)

UFO Program Manager: Philippe JUGE
+33 (0)164919636 / philippe.juge@thalesgroup.com
UFO Technical Manager : Frédéric BARBARESCO
+33 (0)630071419 / frederic.barbaresco@thalesgroup.com
UFO Coordinator : Fabrice ORLANDI
+33 (0)164916419 / fabrice.orlandi@thalesgroup.com
THALES LAND & AIR SYSTEMS,
Voie Pierre-Gilles de Gennes F-91470 Limours – France

UFO Project Office: Hugues FELIX,
EUROPEAN COMMISSION, DG RESEARCH & INNOVATION, AERONAUTICS
CDMA 04/160, B-1049 Brussels - Belgium
+32 229-86172 / hugues.felix@ec.europa.eu