Wakenet 3-Europe

3rd Major Workshop : Southampton, 10th & 11th of May 2011
SESAR Project 12.2.2
JF.MONEUSE
Thales Air Systems
Runway Wake Vortex Detection, Prediction and Decision Support Tools

12.2.2 executed in tight interaction with 6.8.1 operational project
12.2.2 and 10.4.4 complementarity / related areas

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Safely reduce wake vortex separations for arrival & departures

Define, analyse, develop and verify a Wake Vortex Decision Support System (WVDSS)

- satisfying 6.8.1 operational concept
- delivering position & strength of wake vortices
- predicting wake vortices behavior and impact on safety & capacity
- advising stakeholders (ATCOs, Supervisors, …)

WVDSS Handling & Processing

- Weather & surveillance informations, airport specific climatological conditions, aircraft characteristics, runways layout

WVDSS able to bring solutions to Wake Vortex concerns, taking into account airport infrastructure, layout and weather conditions
WVDSS built in three iterative phases dealing with the three steps of the SESAR Concept Story Board

- **TBS (Time Based Separation) – step 1**
  - Acquisition and processing of information about position, strength and behavior of wake vortex in case of significant headwind

- **WDS (Weather Dependant Separation) – step 2**
  - Real time assessment of wake vortex position, strength; and prediction of wake vortex behavior to allow separation reduction; depending on weather conditions

- **PWS (Pair Wise Separation) – step 3**
  - Demonstration of the system capacity to dynamically deliver separation per aircraft pairs; requires aircraft characteristics database (generation of wake vortex, sensitivity to wake vortex). Customization to different airports and runways configurations

- **WVDSS is an enabler for validation of operational concept**

WVDSS pragmatic & iterative development

WVDSS able to optimize runways throughput and reduce delays on different kind of airports as well as to be adapted to several runway configurations
### 12.2.2 Project schedule overview

<table>
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<th>Phase 1</th>
<th>Phase 2</th>
<th>Phase 3</th>
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**Full scale simulation model**

**Model calibration & validation**

#### Phase 1
- **Data acquisition:**
  - Sensors Benchmark (CDG)
- **WV sensors:**
  - X-band radar (mech scan)
  - 1.5 µm Lidar
- **Weather Sensors:**
  - Anemometers
  - Lidar Wind Profiler
  - UHF Radar Wind Profiler
  - SODAR
  - X-band weather radar
  - Visibility

#### Phase 2
- **Partial prototype:**
  - "Off-Line" demonstration
  - Time Based Separation (CDG)
- **WV sensors:**
  - X-band radar (mech scan)
  - 1.5 µm Lidar
- **Weather Sensors:**
  - Anemometers
  - Lidar Wind Profiler
  - UHF Radar Wind Profiler
  - SODAR
  - X-band weather radar
  - Visibility
- **WVAS System:**
  - Separation Mode Planner
  - Wake Vortex Predictors
  - WV Alerts
  - Operator HMI

#### Phase 3
- **Full scale prototype:**
  - "Shadow Mode"
  - Weather Dependant Separation (CDG)
- **WV sensors:**
  - X-band radar (elec scan)
  - 1.5 µm Lidar
- **Weather Sensors:**
  - Selected Wind profiling sensors
- **WVAS System:**
  - Separation Mode Planner
  - Wake Vortex Predictors
  - WV Alerts
  - Operator HMI

#### XP Trials
- **XP0 Trials**
  - May-June 2011
  - Data acquisition:
    - Sensors Benchmark (CDG)
  - **WV sensors:**
    - X-band radar (mech scan)
    - 1.5 µm Lidar
  - **Weather Sensors:**
    - Anemometers
    - Lidar Wind Profiler
    - UHF Radar Wind Profiler
    - SODAR
    - X-band weather radar
    - Visibility

- **XP1 Trials**
  - Partial prototype:
    - "Off-Line" demonstration
    - Time Based Separation (CDG)
  - **WV sensors:**
    - X-band radar (elec scan)
    - 1.5 µm Lidar
  - **Weather Sensors:**
    - Selected Wind profiling sensors

- **XP2 Trials**
  - Full scale prototype:
    - "Shadow Mode"
    - Weather Dependant Separation (CDG)
  - **WV sensors:**
    - X-band radar (elec scan)
    - 1.5 µm Lidar
  - **Weather Sensors:**
    - Selected Wind profiling sensors

- **XP3 Trials**
  - Full scale updated prototype:
    - "Shadow Mode"
    - Pair Wise Separation (Frankfurt)
  - **WV sensors:**
    - X-band radar (elec scan)
    - 1.5 µm Lidar
  - **Weather Sensors:**
    - Selected Wind profiling sensors

**Note:** The Wake Vortex Advisory System: WVAS

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12.2.2 Phase 1: Where we are & where we go

2010 achievements & deliveries

- Preliminary System Requirements 2010/07/20
- Preliminary System Architecture 2010/10/27

2011 on going tasks & planned tasks

- Initial Technology studies 2011/03/01 2011/09/30
- XP0 Campaign – benchmark wake vortex and weather sensors 2011/05/09 -> 2011/06/10
- Adaptation of system requirements for TBS 2011/10/31
- Adaptation of system architecture for TBS 2011/12/30
- System Development Q4 2011 -> mid 2012
- System Verification Q1 2012 -> end 2012

12.2.2 prototype delivery by end of 2012 for operational validation
WVDSS Architecture for XP0

Meteo Centre

Local Meteo Sensors
- Anemometers Vent-9 & Vent-27
- UHF Wind Profiler PCL-1300 of MF
- SODAR
- LIDAR Wind Profiler WINDCUBE-70
- LIDAR scanner WINDCUBE-200
- Weather Radar

External Weather Observations

Recorder
Recorder
Recorder
Recorder
Recorder

Wake Vortex Decision Support System

Wake Vortex Sensors
- Mechanical scan X Band Radar BOR-A
- Lidar 1.5 um WINDCUBE-200
- WV Radar Data Recorder
- WV Lidar Data Recorder

Wake Vortex Location/Strength & short prediction

ATC & Airport Systems

Aircraft Characteristics + 4D trajectory

Meteo Nowcast (Wind Profile)

Recorder

Air Traffic Data Recorder
XP0 CDG Trials: WV & Wind Sensors Deployment

- Wake Vortex
- X-band Radar
- Wind Sensors Deployment
- 1.5 μm Lidar Scanner
- Sodar
- UFR Radar
- Wind Profiler
- Visibility
- Anemometers
- Wake Vortex & Wind Profiler
- 1.5 μm Radar Scanner
- Wake Vortex & Wind 1.5 μm Lidar Scanner
- UFR Radar Wind Profiler

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Characteristics of all sensors deployed

**Wake Vortex sensors**
- X band radar BOR-A (THALES)
- Windcube 200S scanner Lidar (LEOSPHERE)

**Weather sensors**
- Anemometers (METEO FRANCE)
- Windcube 70 wind profiler Lidar (LEOSPHERE)
- SODAR (METEO FRANCE)
- UHF Wind Profiler radar-PCL1300 (METEO FRANCE)
- UHF Wind Profiler radar-PCL1300 (DEGREANE-HORIZON)
WVDSS Architecture for Phase 1 and beyond

Wake Vortex Decision Support System

Local Meteo Sensors
- Anemometers
- UHF Wind Profiler
- SODAR/RASS
- Weather LIDAR
- 1.5 µm LIDAR
- X Band Radar

Local Weather Nowcast & Forecast
- MHHPS
- Turbulences Calculation

Data Fusion

Wake Vortex Sensors
- Radar Wake Processing
- Lidar Wake Processing

Wake Plots Tracking

Input / Output
- Separation Mode Planner
- Wake Vortex Predictor
- Monitoring & Alerting
- Wake Vortex Advisory System

External Weather Observations
- INT-EXT-MET

ATC & Airport Systems
- Radar Front-End
- Lidar Front-End
- Electronic-scan Radar 1.5 µm WV Lidar
- Wake Vortex Sensors
- Wake Vortex Advisory System

Supervisor
- Approach
- Tower

HMI

Local Weather Data Cube

Aircraft Characteristics + 4D trajectory

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NSV-4 Aerodrome ATC System

Aerodrome ATC performs

- Surveillance
- Taxi Conformance Monitoring
- Ground Correlation Manager
- Departure Management
- Aerodrome Flight Data Processing
- Conflict Detection
- Support Functions
- Time Based Separation

- Controller Human Machine Interaction Management
- Operational Supervision
- Technical Supervision
- Air-Ground Datalink Management
- Ground-Ground IOP/SWIM Management
- A-G Voice Communications
- G-G Voice Communications

- Surface Movement Planning
- Surface Guidance Management
- Airport Resource Management

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NSV-4 Diagrams

1 External Weather Observations
2 En-Route / Approach Air Situation and Flight Plan data

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Thank-You for your attention
Questions?