SESAR P12.2.2 progress & CDG campaign presentation

WakeNet EU 13/05/2014
Ph. Juge
◆ Development and Validation in close cooperation with P06.08.01 (operational project)

◆ Validation in platform
  ○ System performances assessment
  ○ Validation on specific scenario
  ○ Human factors

◆ 2 validation exercises planned
  ○ Time Based Separation + RECAT-EU+ initial RECAT2: Oct 2014
  ○ Weather Dependant Separation + RECAT2 : Oct 2015

◆ Large scale on field validation
  ○ Need to get enough data to build a statistic assessment
  ○ Preparation of SPR
  ○ Preparation of CBA

◆ One year trials campaign in CDG: mid 2014 – mid 2015
Wake Vortex Decision Support System (WVDSS) Architecture

Wake Vortex Detection, Prediction and decision support tools

Local Meteo Sensors
- Anemometers
- UHF Wind Profiler
- Lidar W200S
- X Band Radar (MFR)

Local Weather Nowcast & Forecast
- MHRPS

Wake Vortex Sensors
- Radar Wake Processing
- Lidar Wake Processing

Wake Vortex Advisories System
- Separation Mode Planner
- Wake Vortex Predictor
- Monitoring & Alerting

ATC & Airport Systems
- Aircraft Characteristics + 4D trajectory

External Weather Observations

Meteo Centre

HMI
- Supervisor
- Approach
- Tower

Input / Output

INT-EXT-MET

INT-ITWS-1

INT-LWF-1

INT-LWF-2

INT-LWFN-1

INT-WVAS-1

INT-WVAS-2

INT-WVAS-3

INT-WVAS-4

INT-WVAS-5

INT-WVAS-6

INT-ATCS-1

INT-ATCS-2

INT-ATCS-3

INT-ATCS-4

INT-ITWS-2

INT-ITWS-3
Validation Exercises Configuration

- Simulated sensor alerts
- Weather scenario (Wind, EDR)
- Traffic scenario
- WV separation (RECAT)

WVDSS
Wake-Vortex Separation

AMAN (MAESTRO)

Sequence

Thales Air Systems
Wavenet 13/05/2014
WVDSS with ORD concept

< FTD, Targeted Separation
< ITD, Current Separation

New HMI for TBS (Time Base Separation)  
ORD concept
Enhance the scope
Solution to optimize traffic flow and capacity with same level of safety with automations

**The global picture: Wake-Vortex & Runway Throughput**

**WVAMAN**
- **Arrival Scheduling:** Optimal RECAT Sequencing coupled with P-Merge Procedure

**WVDSS**
- **Arrival Separation:** RECAT 1/2/3 Wake-Vortex Separation in the glide

**WVSafetyNet**
- **Alerts & Go-Around:** Wake-Vortex Monitoring (alt. < 100 m) and Wind/EDR Monitoring (alt. < 500 m)

**WVDMAN**
- **Departure Scheduling:** Optimal Take off RECAT Sequencing at the runway coupled with Weather-Dependent Procedures
**AMAN with Wake-Vortex constraints**

- AMAN should take into account Wake-Vortex separations constraints (RECAT 1 / 2 & 3) to optimize Airport throughput
- THALES is developing advanced algorithm to optimize sequencing for airport capacity improvement
- This algorithm could be tested for different airport traffic mix and runways layout

**AMAN & Optimal Sequencing**

- Non coordinated A380 Arrivals could greatly trouble Airport Capacity
  - **Bad Sequence**: A380 – (7 NM) - A320 – (3 NM) - A380 – (7 NM) - A320 = 17 NM
  - **Good Sequence**: A380 – (3 NM) - A380 – (7 NM) - A320 – (3 NM) - A320 = 13 NM
## Initial arrival sequence

<table>
<thead>
<tr>
<th>Callsign</th>
<th>WTC</th>
<th>Class</th>
<th>STA</th>
<th>Sep. min</th>
<th>ETA min</th>
<th>ETA max</th>
<th>Delay</th>
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<tr>
<td>UPM100</td>
<td>M</td>
<td>D</td>
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<td>10:09:00</td>
<td>10:16:00</td>
<td>1'00</td>
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<tr>
<td>LIG001</td>
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<td>F</td>
<td>10:12:00</td>
<td>120</td>
<td>10:10:00</td>
<td>10:15:00</td>
<td>2'00</td>
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<td>A</td>
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<td>60</td>
<td>10:11:00</td>
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<tr>
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<td>B</td>
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<td>60</td>
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<td>5'12</td>
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<tr>
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<td>F</td>
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<td>10:15:00</td>
<td>10:22:00</td>
<td>6'00</td>
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<tr>
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<td>10:22:30</td>
<td>60</td>
<td>10:20:00</td>
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Total Length: 12'30

## Optimized arrival sequence

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<th>Sep. min</th>
<th>ETA min</th>
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<td></td>
</tr>
<tr>
<td>LIG001</td>
<td>L</td>
<td>F</td>
<td>10:12:00</td>
<td>120</td>
<td>10:10:00</td>
<td>10:15:00</td>
<td>2'00</td>
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<td>10:22:00</td>
<td>0'00</td>
</tr>
<tr>
<td>SUH002</td>
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<td>A</td>
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<td>60</td>
<td>10:11:00</td>
<td>10:18:00</td>
<td>5'30</td>
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<tr>
<td>UPH004</td>
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<tr>
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<td>E</td>
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<td>120</td>
<td>10:20:00</td>
<td>10:28:00</td>
<td>0'06</td>
</tr>
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Total Length: 10'06

## Shorten the sequence without increasing the overall delay

Total: 14'06
Paris ACC has implemented a high altitude approach procedure which is more efficient for handling North-West flights of the Paris region to Paris-Charles de Gaulle airport. This is a first in the Core Area which deals with the most dense and complex traffic at the heart of Europe.
Runway Occupancy Time: Rationale

- Runway Excursion (Primary cause of accident):
  - An aircraft veering off the side of the runway (cross wind)
  - Overrun at the very end of the runway

- Aircraft Braking Performance depend on:
  - Runway Contaminant
  - Runway friction
  - Final Landing speed (dependent of Head/Tailwind)
  - Aircraft Weight and Braking strategy

- and will impact:
  - SAFETY (Accident /Incident or Go-Around)
    - Runway Excursion
    - Aircraft collision (Runway Occupancy Time < Landing Time Interval)
  - CAPACITY (movement per hour)
    - Runway Throughput limited by Runway Occupancy Time
    - Braking distance not adapted to Exit Taxiway (selected by Controller/Pilot 30 m before landing)
    - Separation=Max(ROT, Wake-Vortex Separation)
**Cumulative Rain 30 min prior before landing**

- **Rain Rate Retrieval around the airport**
  - THALES High Resolution (5 m) / High Speed (45 s) X-band Radar
  - BOSCHUNG Water Level IT-Sens® probes installed on runways
  - Rain gauges data deployed around the airport

- **Cumulated Rain Forecasting by RHEA CALAMAR**
  - Cumulative Forecast Rainfall based on data in 1 min increments for periods up to 30 mn /1 hour ahead
  - Forecast reliability by the supply of data from rain gauges/ Water level probes (calibration)

- **Runway Contaminant Forecasting by DGAC/STAC**
  - Water Run-off model
    - 3D map of Runway defined by Laser scanning instrument
    - Run-off model based on cumulate rain and runway slope
    - Recommendations for ICAO Friction Task Force

- **Coordination with Airborne ROPS (Thales Av.)**
THALES has developed a global “Wake-Vortex System (WVS)” simulator to assess airport capacity gain.

This simulator integrates models of main factors and components impacting the runway throughput.

This simulator includes:

- Time of aircrafts on runways: Runway Occupancy Time (ROT) that is modeled statistically indexed by weather conditions (runway contaminant, head wind) and aircraft momentum (Maximum Landing Weight x Final Speed Approach)

- Wake-Vortex Separation of aircrafts in the glide slope: WVDSS (Wake-Vortex Decision Support System) that monitor safe separation between aircraft in final approach phase taking into account new fixed procedures (ICAO, RECAT 1 and RECAT 2) or dynamical one (Weather dependent & Dynamic Pairwise RECAT 3)

- Aircrafts sequence in the TMA: Wake-Vortex Constrained AMAN (Arrival MANager) that generates optimal time-efficient sequence of aircrafts in TMA taking into account wake-vortex pairwise separations constraints.

The simulation is developed with SCANSIM that is a comprehensive and cost-effective ATC simulator suite for ATC training.

We could study Point-Merge procedure coupled with AMAN.
How to boost airport capacity?

Today’s offer

- WV Decision Support System (+ SAFETY Net)
- WV Separation on AMAN/DMAN
- BTV tool for ROT Reduction
- WV predictor & detection
- MET infos & forecast
- RECAT
- Point-Merge

Solutions

- WV : Wake Vortex
- BTV Break to Vacate
- ROT : Runway Occupancy Time

Technologies

- Maestro
- SCANSIM
- TopSky - Tower
- TopSky - ATC
- TopSky – Safety Nets
- Sensors

Answer

Airport Runway Capacity Booster
Presentation of trials campaign in CDG Airport
In coordination with P6.8.1 deployment of X-Band radar and Lidar to perform wake vortex measurements.

Objectives:

- Gather data to feed the safety case and cost benefit assessment
- Benchmark wake vortices tracking position and strength
- Build a A380 WV measurement database
- Increase Heavy WV database for RECAT2
- Monitor RECAT-EU implementation
- Work on WV severity by crossing WV measurements vs FDR data

Schedule

- Sensors deployment : from July 2014
- Start of operational campaign : 1st September 2014
- Duration : 1 year
CDG campaign: THALES Radar/Lidar sensors suite

- **Radar/Lidar Combination**
  - X-band Radar in Wet/Foggy conditions
  - 1.5 micron Lidar in Dry Conditions

- **3D scanner capabilities**
  - Multi-function sensors (modes interleaving)
    - Detection of wake-vortex (positions scanned every 7.5 s)
    - Wake-Vortex Strength Retrieval (Circulation in \( m^2/s \))
    - Wind that induces Wake-Vortex Transport
    - Air turbulence by EDR (Eddy Dissipation Rate) that induces Wake-Vortex Decay
    - Rain Rate (Radar) for ground segment of ROT

- **Additional functions**
  - Wind-Shear
  - Wind Burst / Microburst
CDG campaign : THALES Radar/Lidar sensors suite

- **Collaborative Resources management**
  - Collaborative modes between Radar and Lidar according to weather conditions

- **THALES Radar/Lidar Sensors have been calibrated based on:**
  - Collaboration with AIRBUS on flight trials at Toulouse Airport

- **These sensors are operational to:**
  - Develop a Wake-Vortex Database
  - Feed Safety Cases for RECAT deployment
  - Support Airport Capacity study

The database structure could (should?) be discussed within the wake vortex community
Wake Vortex Solutions
Mitigating the Impact of Wake Vortices

Optimal aircraft sequencing
Capacity
Safety

Wake vortex pairwise separation management
Runway throughput boost
Runway Occupancy Time Reduction