WakeNet3-Europe – 3rd Major Workshop
10-11 May 2011 - Southampton

SESAR projects 9.11/9.30
Current status and activities

Presented by
S. Kauertz & A. Reinke / Turbulence Hazards Team
Vision

• Today,

  wake turbulence separation requirements limit airport capacity;
  wake turbulence encounters occur regularly and during all phases of flight;
  traffic density increases, and the situation must be expected to worsen;

• Tomorrow,

  Wake Encounter Prevention Systems (WEPS)
  will help to increase air transport
  Safety and Capacity
Vision

Wake Encounter Prevention System:

WEPS

WEPS-P (Prediction)
WVE conflict prediction, alerting and avoidance (surveillance)

WEPS-C (Control)
Increased aircraft stabilization by Flight Control during WVE
## Outline

- Introduction
- First project results
- Current activities
- Outlook – next activities
# Introduction

- **SESAR P9.11**
  "Aircraft Systems for Wake Encounter Alleviation" → WEPS-P

- **SESAR P9.30**
  "Weather Hazards / Wake Vortex Sensor" → WEPS-C

- Both projects
  - are managed by Airbus
  - have Airbus as sole contributing (SESAR-JU) partner
  - have entered into execution in June 2010
  - are fully launched by now and first outputs are available
Introduction

WEPS-P

• WVE conflict prediction, alerting and avoidance (surveillance)

• Based on models and enabled by air-to-air data exchange

• Benefits
  • Safety net against wake-induced incidents
  • Reduced wake turbulence separation for equipped aircraft
  • Reduced landing fees & flight times
Introduction

• WVE conflict prediction, alerting and avoidance (surveillance)

Other Traffic

Air-to-air Data Link

WEPS-P

Equipped A/C

Flight deck alerting

Std avionic products

Avoidance flight path

• Tactical prediction and flight crew alerting of wake encounter events
• Tactical avoidance maneuver
# Introduction

<table>
<thead>
<tr>
<th>WEPS-C</th>
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</thead>
</table>

- Increased aircraft stabilization by F/CTL during WVE

- Enabled by new LiDAR sensor and predictions made by WEPS-P

- Benefits
  - Safety-net against wake-induced incidents
  - Reduced wake turbulence separation for equipped aircraft
  - Reduced landing fees & flight times
Introduction

- Increased aircraft stabilization by F/CTL during WVE
  - Short-range (<100m) measurement of wake disturbance
  - Activation of dedicated flight control response countering wake impact
First results

• Evaluation of results of earlier projects
  • Previous project FLYSAFE defined an *Onboard Wake Prediction and Avoidance System (OBWPA)*
    • OBWPA was assessed by pilots in a development simulator during FLYSAFE
  • In SESAR 9.11/9.30 OBWPA elements are evaluated by Airbus experts for
    • Human Factors
    • Communication/Surveillance
    • Cockpit Operations
  • Furthermore, the OBWPA demonstrator was installed on a flight test aircraft
First results

- Evaluation of results of earlier projects
  - Evaluation of FLYSAFE solution (OBWPA) in flight test:
    - Installation on-board wake-encountering a/c (A320) during A380 wake vortex flight test campaign in Nov. 2010
    - Real-time air-to-air data exchange via VHF between OBWPA and 2 wake-generating aircraft (A380 & A340-600)

Wake visualization seen from encountering aircraft

OBWPA installation on dedicated PC in the cabin
First results

- Evaluation of results of earlier projects
  - Evaluation of FLYSAFE solution (OBWPA) in flight test:
    - Prediction and identification of conflicts on dedicated PC in the background
    - Real-time display of predicted wake locations on dedicated screen in cockpit

Real-time display on dedicated screen
First results

• Evaluation of results of earlier projects
Current activities

• Drafting of system architecture

Global In- and Outputs:
• Identification of the necessary inputs from own and surrounding aircraft
• Identification of interfaces to other systems
• Description of outputs of the system

<table>
<thead>
<tr>
<th>Own A/C Name</th>
<th>Description</th>
<th>Unit</th>
<th>Source</th>
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</thead>
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<td>Time since midnight</td>
<td>msec</td>
<td>GPS</td>
</tr>
<tr>
<td>LAT</td>
<td>Current latitude</td>
<td>deg</td>
<td>GPS</td>
</tr>
<tr>
<td>LAT_ACC</td>
<td>Current latitude accuracy</td>
<td>deg</td>
<td>GPS</td>
</tr>
<tr>
<td>LON</td>
<td>Current longitude</td>
<td>deg</td>
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<td>LON_ACC</td>
<td>Current longitude accuracy</td>
<td>deg</td>
<td>GPS</td>
</tr>
<tr>
<td>GPS_ALT</td>
<td>GPS current Z position</td>
<td>m</td>
<td>GPS</td>
</tr>
<tr>
<td>GPS_ALT_ACC</td>
<td>GPS current Z position accuracy</td>
<td>m</td>
<td>GPS</td>
</tr>
<tr>
<td>ALT</td>
<td>Pressure altitude, STD</td>
<td>ft</td>
<td>ADR</td>
</tr>
<tr>
<td>HGT</td>
<td>Height above ground</td>
<td>m</td>
<td>RA</td>
</tr>
<tr>
<td>MASS</td>
<td>Current aircraft weight</td>
<td>kg</td>
<td>FMS</td>
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<td>SAT</td>
<td>Static air temperature</td>
<td>K</td>
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<tr>
<td>ALPHA</td>
<td>Angle of Attack</td>
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<td>ADR</td>
</tr>
<tr>
<td>BETA</td>
<td>Angle of Sideslip</td>
<td>deg</td>
<td>ADR</td>
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<tr>
<td>RHO</td>
<td>Air density</td>
<td>kg/m³</td>
<td>ADR TBC</td>
</tr>
<tr>
<td>EDR</td>
<td>Eddy Dissipation Rate</td>
<td>m²/s³</td>
<td>TBD</td>
</tr>
</tbody>
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**Current activities**

- **Drafting of Operational Concept**

- **WEPS shall be available during the following flight phases:**
  - **Pre-take-off** *
  - **Take-off** **
  - **Climb & departure**
  - **Cruise** *(including climb and descent)*
  - **TMA operations**
  - **Final approach**

* Prior to take-off, WEPS-P provides advisories to delay take-off
** During the take-off run, WEPS-P advisories raised prior to take-off remain active as long as the conflict remains
Current activities

• **Drafting of Operational Concept**

<table>
<thead>
<tr>
<th>Advisory</th>
<th>Caution</th>
<th>Warning</th>
<th>Clear of Conflict</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong></td>
<td><strong>C</strong></td>
<td><strong>W</strong></td>
<td><strong>C</strong></td>
</tr>
</tbody>
</table>

**Basic concept elements for each flight phase (preliminary):**

<table>
<thead>
<tr>
<th>Flight Phase</th>
<th>Alerting</th>
<th>Avoidance</th>
<th>ATC interaction</th>
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</thead>
<tbody>
<tr>
<td>Pre-Take-off</td>
<td><strong>A</strong></td>
<td>Delayed take-off</td>
<td>Procedural R/T</td>
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<tr>
<td>Take-off</td>
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<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Climb/Descent</td>
<td><strong>A</strong></td>
<td><strong>C</strong></td>
<td><strong>W</strong></td>
</tr>
<tr>
<td>Cruise</td>
<td><strong>A</strong></td>
<td><strong>C</strong></td>
<td><strong>W</strong></td>
</tr>
<tr>
<td>TMA</td>
<td><strong>A</strong></td>
<td><strong>C</strong></td>
<td><strong>W</strong></td>
</tr>
<tr>
<td>Final Approach</td>
<td><strong>A</strong></td>
<td><strong>C</strong></td>
<td><strong>W</strong></td>
</tr>
</tbody>
</table>
Current activities

- **Start of technical development activities**
  - Sub-contract launched with DLR, covering
    - Wake modeling/prediction (P2P)
    - Weather modeling
    - Wake alleviation using flight controls
    - Conflict detection & resolution
  - Sub-contract about to be launched with UCL
    - Wake modeling/prediction (PVM)
    - Sub-contract launched with EADS-IW
      - LiDAR sensor expertise
    - Update of VESA simulation tool
### Next activities

**Preparation of simulation/validation platforms with updated technical elements**
- Wake prediction models
- Consolidation of traffic & weather data input received via data link
- Flight control functions for wake encounter alleviation

**Definition of an Initial Operational Concept & Procedures**
- Baseline for pilot & expert evaluations

**Benefit analysis**
- How many wake encounters can be detected/prevented by the system?
Thank you