WakeNet3-Europe

Overview of active wake vortex concepts in Europe

August 2009

Prepared by Dr. Debbie Mitchell

Contents

- This presentation gives a summary of the major wake vortex concepts at the pre-implementation stage in Europe, including any recent developments and highlights. The wake vortex Groups and concepts considered are:
- **Wakenet3-Europe**
- **The European Wake Vortex Task Force (WVTF)**
- **Crosswind concepts:**
  - Crosswind Reduced Separations for Departure Operations (**CREDOS**)
  - Wake Independent Departure and Arrival Operations (**WIDAO**)
  - Closely-Spaced Parallel Runway (CSPR) Arrivals (**HALS/DTOP**)
- **Time-Based Spacing (TBS)**
- **Wake vortex recategorisation (RECAT)**
- **Wake vortex prediction/detection and avoidance projects**
  - **Flysafe**
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WakeNet3-Europe

- The Co-ordination Action **WakeNet3-Europe** promotes multidisciplinary information exchange between scientific and operational specialists in the field of **wake turbulence**.
- **WakeNet3-Europe** is funded by the European Commission within the 7th Framework Programme (2008 - 2011). It continues the work of WakeNet and WakeNet2-Europe and co-operates with other WakeNets worldwide (e.g. WakeNet-US, WakeNet-Russia).
- The aim of **Wakenet3-Europe** is to enable the development of a shared view on how to address capacity limitations caused by wake turbulence separations and how to assure air transport safety with regard to wake vortex encounters despite increasing air traffic density and increasing diversity of the operational aircraft fleet.
- For information about **Wakenet3-Europe** partners, deliverables, background, etc, please visit the website **http://www.wakenet3-europe.eu/**

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- **WakeNet3-Europe** is divided into three Co-ordination Areas, each of which comprise several Task Groups. Each Task Group deals with one specific wake vortex related issue and is lead by one **WakeNet3-Europe** partner (see website for details).
- **Co-ordination Area 3** is focussed on **wake vortex concepts** and is led by **NATS.**
- A key objective of Co-ordination Area 3 is "To provide information exchange between those working on wake vortex concepts, which are in the pre-implementation stage and operational stakeholders. This facilitates that appropriate scientific support is given to such concepts."
- To enable the dissemination of information about wake vortex concepts to operational stakeholders, a **bulletin containing updates and highlights** will be sent out every six months to coincide with the meetings of the European Wake Vortex Task Force.

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The EUROCONTROL Wake Vortex Task Force

- The **EUROCONTROL Wake Vortex Task Force** (WVTF) is a non-permanent group of the Airspace and Navigation Team and the Airport Operations Team formed in order to support the: **Time-Based Spacing (TBS**), Re-categorisation of the Wake Turbulence Separation Minima (**RECAT**) and **Crosswind Procedures** projects with technical and operational expertise.
- The WVTF co-ordinates development activities between EUROCONTROL and the FAA and facilitates the approach to ICAO for rule changes.
- The WVTF meet every six months and the last meeting took place on 12th May 2009 in Brussels (third meeting). Minutes from the third WVTF meeting have been distributed with this presentation.
- A EUROCONTROL Wake Vortex website is currently in the process of being developed.

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Crosswind Concepts

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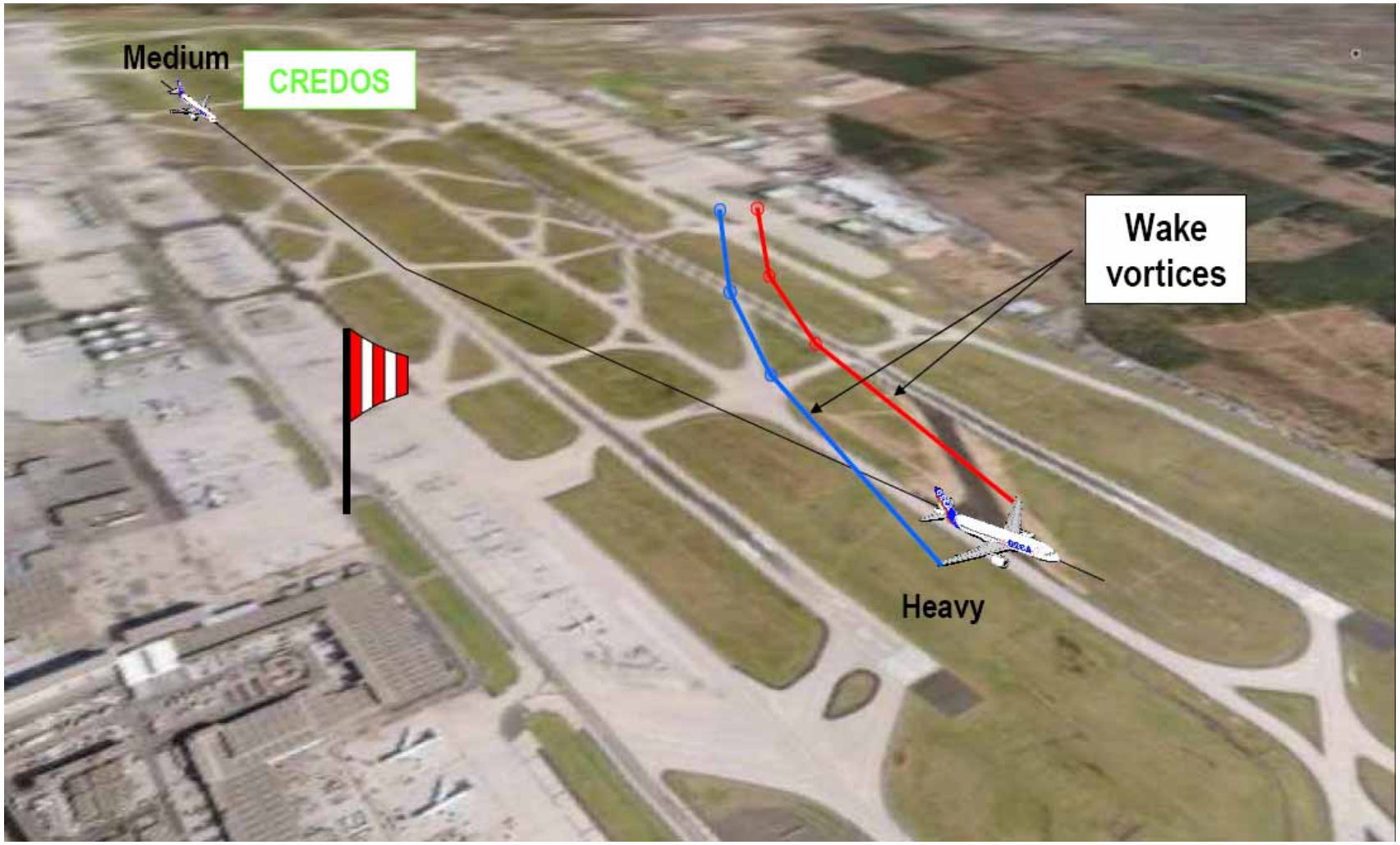
Crosswind-Reduced Separations for Departure Operations (CREDOS) - Concept

- CREDOS is a project of the 6th Framework Programme of the European Commission and is co-ordinated by EUROCONTROL.
- The CREDOS concept involves **suspending wake turbulence separations** under specific crosswind conditions for single runway departures.
- CREDOS assumes that a LIGHT, MEDIUM or HEAVY aircraft departing behind a HEAVY aircraft, or a LIGHT aircraft departing behind a MEDIUM aircraft, needs no wake turbulence separation in time or distance when crosswinds are supposed to be sufficient to transport any hazardous turbulence out of the track of a following aircraft.
- The benefit of CREDOS is to **temporarily increase the departure runway throughput** so that it absorbs capacity peaks or reduces departure delays. An increased departure throughput is mainly to be realised by reducing the separation to below the presently used 2 minutes, applicable for HEAVY-MEDIUM, MEDIUM-LIGHT and HEAVY-LIGHT aircraft combinations.
- The aim of the CREDOS project is to demonstrate whether this conditional approach to reducing separations is valid and feasible.
- Website: http://www.eurocontrol.int/eec/credos/public/subsite_homepage/homepage.html

Contact: Marie-Thérèse-Meloni [marie-therese.meloni@eurocontrol.int]

CREDOS – Concept Illustration



CREDOS – Objectives and Deliverables

The **objectives** of the CREDOS project are to:

- Increase the body of knowledge relating to wake turbulence behaviour during the initial climb phase of flight. Of particular concern is the crosswind conditions under which the wake turbulence is blown laterally away from the runway, thus allowing a following aircraft to take-off sooner than is currently permitted by the ICAO standards.
- Develop, and then demonstrate the feasibility of a concept of operations allowing reduced separations for single runway departures under sufficient crosswind conditions.
- Provide all stakeholders with the required information to facilitate the implementation of the CREDOS concept of operations in the near-term (pre-2012).

The key **deliverables** of the CREDOS project are:

- A validated concept of operations for reduced separations for crosswind departures.
- End-users support packages & guidance.
- Enhanced wake vortex behaviour models and encounter risk models capable of use for departure situations.
- Proven wake vortex detection configuration for departures.
- Database of wake vortex recordings for departures including meteorological conditions from two sites.
- Documented application of validation.

CREDOS – Project Status

Progress to date

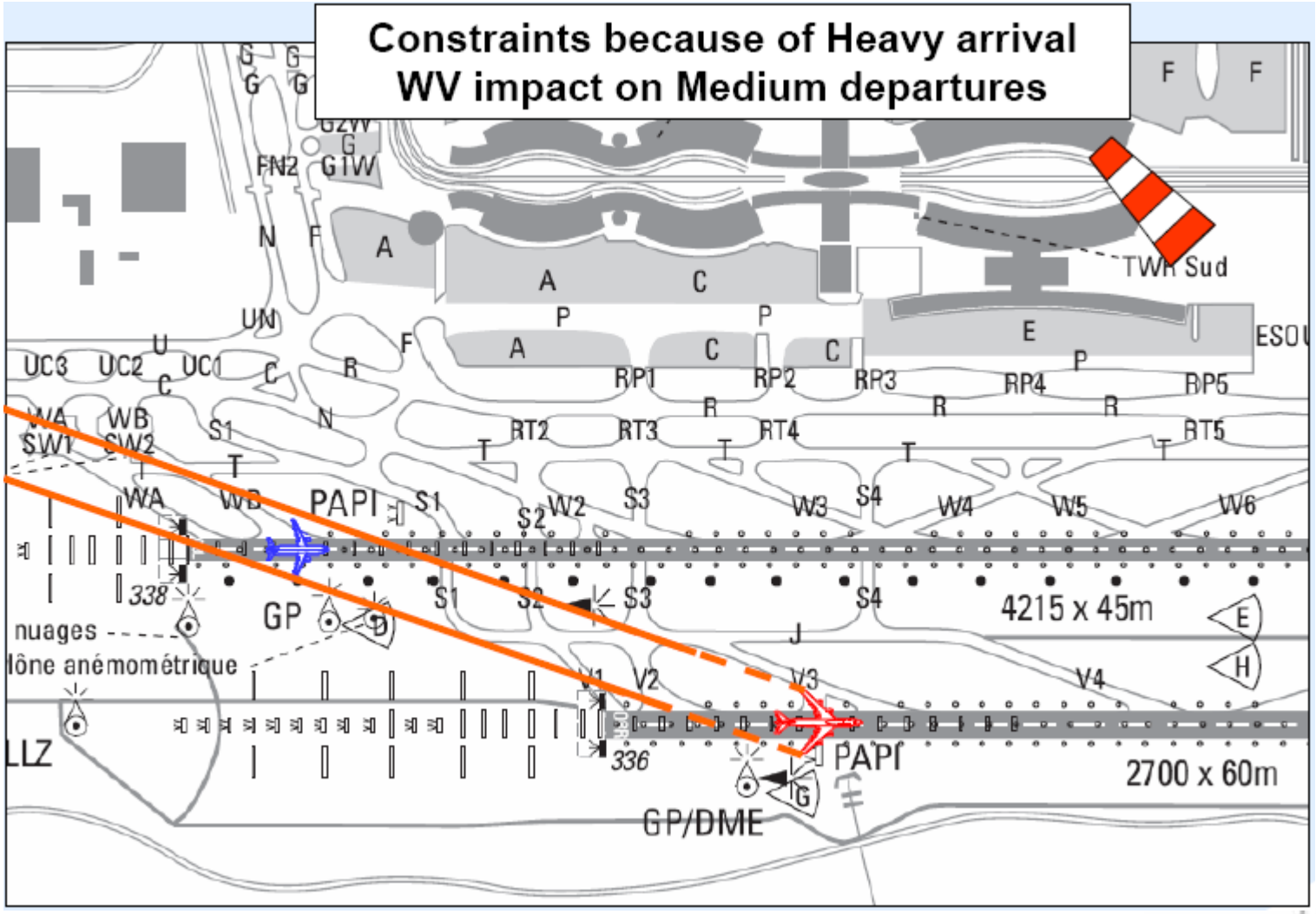
- The CREDOS concept of operations is in draft form and a final version is expected at the end of 2009. This work has been carried out in Work Package 4, which is led by NLR.
- The Human Factors Case and Safety Case have gone through stakeholder consultation and an Environmental Case has also been produced.
- The concept is based on today's technical environment but assumes that a local validation will be carried out via a data collection campaign. This will be achieved using LIDAR and wind meters that will aim to prove that a safe crosswind component can be determined for the runway and first part of the climb path.
- The project is due to be completed at the end of 2009 and a **final dissemination forum** will take place **near Paris on 17th-18th November**. The forum will provide an opportunity to showcase the CREDOS concept to stakeholders. For more details, please contact the project co-ordinator Marie-Thérèse Meloni: marie-therese.meloni@eurocontrol.int
- It is hoped that the concept will be fully validated by 2012.

Wake Independent Departure and Arrival Operations (WIDAO) - Concept

- The purpose of the WIDAO concept is to **relax constraints limiting the efficiency of closely-spaced parallel runway (CSPR) operations.**
- The WIDAO concept is a joint study between EUROCONTROL and DSNA (French ANSP).
- The study concentrated on Paris CDG airport where there are two CSPRs for departing and arriving aircraft. Departing aircraft on one of the runways had to join further down the runway to avoid wake turbulence from aircraft arriving on the adjacent runway.
- The aim of the concept is to allow aircraft to enter at the start of the runway by demonstrating that wake turbulence from aircraft landing on the adjacent runway does not present a significant risk on departure (see schematic on next slide).
- The EUROCONTROL WindTracer was installed on the roof of the K-bis tower at CDG in March 2007. It measured the behaviour of wake vortices generated by arriving traffic and the headwind along the last 4 to 8Nm of the glideslope. Data collection continued until June 2008.
- Initial analyses of the data showed that any vortices detected on the departure runway that had been transported from the arrival runway had decayed to a low-strength.

Contact: Vincent Treve [vincent.treve@eurocontrol.int]

WIDAO – Concept Illustration



WIDAO – Project Status

- The first phase of the Safety Case was presented to the French regulator (DGAC) in 2008 and was approved.
- The Safety Case was based on LIDAR measurements correlated to MET data.
- The first phase implementation of WIDAO commenced on 7th November 2008 at CDG whereby the first set of constraints were relaxed – departing aircraft could enter runway at an earlier entry point, S2.
- The second set of constraints were relaxed in March 2009.
- The third set of constraints will be documented along with first two sets in the final WIDAO safety case.
- This concept will be supported by a wake vortex modelling activity in WAKE4D and results are expected at the end of Summer 2009.
- The project should be complete by the end of 2009.
- The WIDAO concept will be of benefit to other CSPR structures in Europe and it is hoped that generic procedures can be developed that could be adapted to those other airports.
- For more information on WIDAO:

http://www.eurocontrol.int/corporate/gallery/content/public/events/080916wakevortex/Widao.pdf

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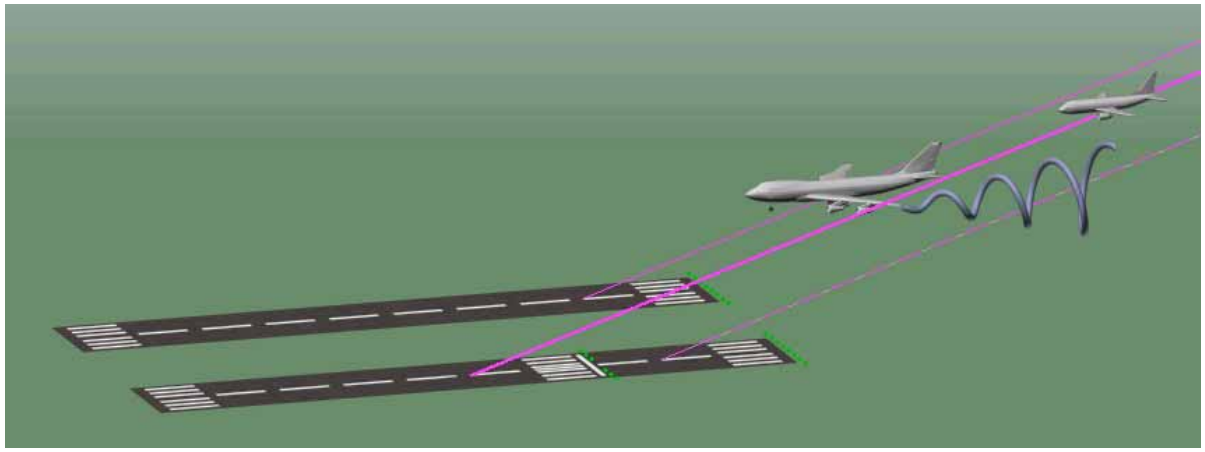
HALS - Concept

- HALS is a concept that was developed and deployed to **allow aircraft to land simultaneously on CSPRs** at Frankfurt Airport.
- The concept involved adopting a second, strongly displaced landing threshold for the southern runway to mitigate against wake turbulence by flying above the vortices of the leading aircraft.
- Because of the horizontal shift of the landing threshold by 1500 meters, the glidepath was 83 meters higher than that of runway 25R.
- This second landing threshold was named 26L and was equipped with a new lighting and marking system designed specifically for this purpose, as well as an instrument landing system that permitted landings up to weather category ILS CAT I.



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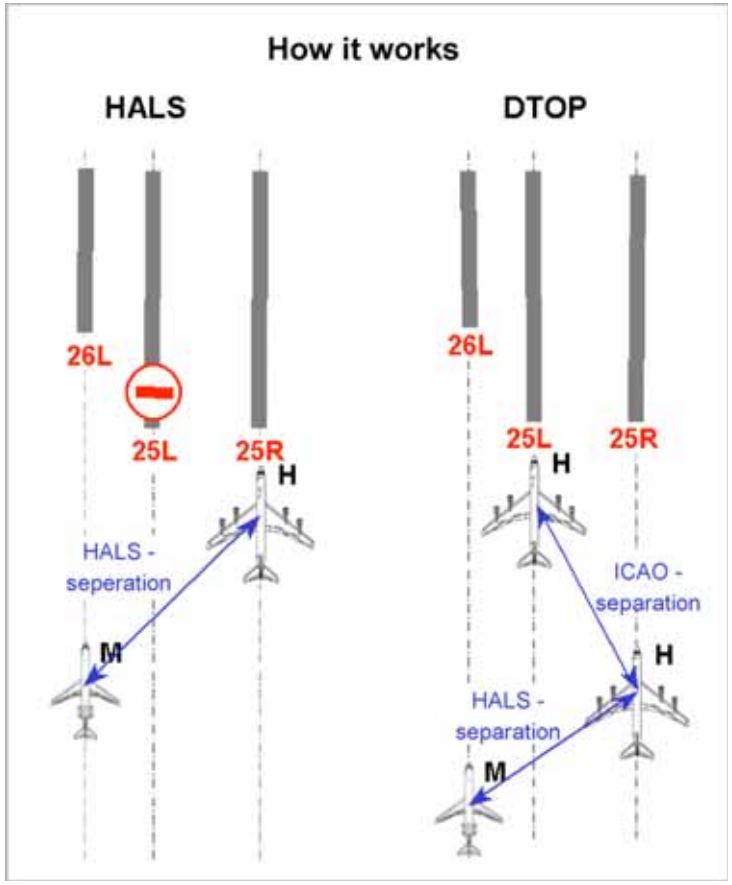
HALS/DTOP - Concept

- With HALS, the conventional 25L threshold cannot be used. Given this, the HALS/DTOP concept was developed to use the two thresholds on the same runway simultaneously in order to achieve a capacity benefit that was not possible with HALS alone
- The new landing procedure HALS/DTOP was considered as an option to solve the capacity problem at Frankfurt Airport.
- The first HALS/DTOP simulator trial was successfully completed in Summer 2004 at Frankfurt. This gave consideration to the demands on pilot workload under different weather conditions in view of the new lighting pattern with two active landing thresholds on one runway.
- Another simulator trial focussing on the controller's situation was completed successfully in 2006.



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HALS/DTOP - Project Status

- Despite successful trials, the HALS system is **no longer operational** at Frankfurt Airport because of the ongoing construction of a new arrivals-only runway, which will solve the capacity problem. All the facilities were removed during the last runway refurbishment in 2007/2008.

- However, the HALS/DTOP concept could be adopted elsewhere.

- For more information on HALS/DTOP:
  http://www.fraport.com/cms/company/dok/81/81482.halsdtop.htm

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Time-Based Spacing - Concept

- The Time-Based Spacing (TBS) concept aims to prevent the loss of runway arrival throughput, due to strong headwind conditions, whilst maintaining the required levels of safety.
- The TBS concept **would replace the existing Distance-Based Separations (DBS) with the equivalent minimum time intervals** between successive arrivals while on final approach. This would compensate for the reduction in runway capacity observed during strong headwind conditions with DBS.
- The application of minimum TBS intervals on final approach will enable ATC to sustain runway arrival throughput rates in all headwind conditions at values close to the throughput rates achieved in calm wind conditions with DBS.
- The concept is beneficial for capacity-constrained aerodromes where there is a high arrival demand.
- The TBS project is co-ordinated between EUROCONTROL and NATS, whereby NATS are currently developing a local validation case specifically for adopting TBS operations at London Heathrow Airport.

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UK NATS contact: Charles Morris [charles.morris@nats.co.uk]

Time-Based Spacing – Project Status (EUROCONTROL)

- The TBS concept of operations is almost complete, but discussions are taking place between NATS and EUROCONTROL to agree on the definition of TBS - ongoing
- **Initial safety case work** has been undertaken; **real-time simulations** have been carried out; **TBS modelling work** has been performed including missed approach considerations - complete
- Fast-time simulations to be carried out - Q1 2010
- First Functional Hazard Assessment workshop – Q1 2010
- Operational trials - TBD
- Preliminary Safety Case - Q3 2010
- Proposals to ICAO - at the end of 2011
- Co-ordination between NATS and Eurocontrol - ongoing

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Time-Based Spacing – Project Status (UK)

- **Safety case development**
  - Data collection campaign on final approach at Heathrow using EUROCONTROL WindTracer LIDAR unit to measure wake vortices in or near ground effect (IGE/NGE) – Oct 2008 to Sep 2009 (may be extended by six months)
  - As above for wake vortices out of ground effect (OGE) – April 2010 to March 2011 (unconfirmed)
  - Final TBS Safety Validation Report for NGE/IGE – January 2010 (if campaign not extended)
  - Final TBS Safety Validation Report for OGE – July 2011 (unconfirmed)
- **Stakeholder consultation**
  - Internal NATS stakeholder consultation – November 2009
  - CAA stakeholder consultation – January 2010
  - External stakeholder consultation (e.g. airlines) – March 2010
- Business Case and Environmental Case – planned 2010
- Establish TBS rules and procedures - ongoing
- Establish the regulatory and legal case for the TBS concept – planned to become regulator-approved in 2012

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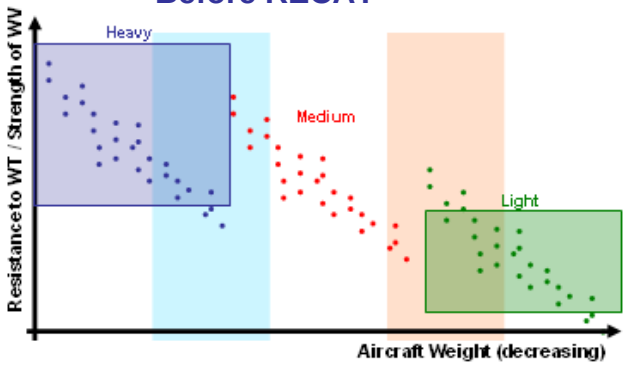
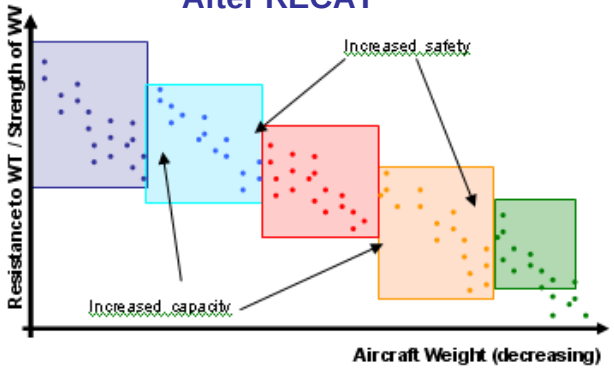
Revising wake turbulence categories to gain capacity (RECAT) – Concept

- RECAT is a recent EUROCONTOL-FAA initiative to increase capacity at airports through **redefining wake turbulence categories** and the associated minimum separations with the same or improved level of safety.
- RECAT will propose ICAO make an amendment to the existing wake turbulence categories and their associated prescribed separations.
- These new separations will be assessed using the latest models for wake behaviour, as well as models that estimate the impact of the wake on the Following aircraft.

Before RECAT



After RECAT



- For more information on RECAT: http://www.eurocontrol.int/eec/public/standard_page/EEC_News_2008_3_RECAT.html

Contact: Catalin Lepadatu [catalin.lepadatu@eurocontrol.int]

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Revising wake turbulence categories to gain capacity (RECAT) – Project Status

- Concept of operations is not available yet as it is in the early stages of development.
- Modelling work package – almost complete.
- Safety Case work – just started and to be completed by June 2010.
- Human Factors Case – will start in Autumn 2009.
- Business Case – will start in Autumn 2009.
- Wake turbulence categories and separations finalised for validation and approval by ANSPs – September 2009.
- First phase of RECAT – to be completed by end of 2011.
- Once the first modification of the wake vortex categories has been proposed to ICAO, the objective is to further develop the RECAT project towards a dynamic categorisation of aircraft and separation minimum estimation that would cope both with local conditions at a given airport and with weather conditions, in order to increase capacity and safety further.

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Wake turbulence prediction, detection and avoidance projects and concepts

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Green-Wake - Concept

- Green-Wake is a three-year EC project of the 7th Framework Programme. It is a 36-month programme that started in November 2008.
- The objective of Green-Wake is to develop and validate innovative technologies that will detect wake vortex and wind shear hazards in a timely manner to improve aircraft passenger safety and comfort.
- Green-Wake will also improve the operating efficiency of an aircraft by providing a safe means to decrease separation between trailing aircraft.
- Green-Wake will develop and test an Imaging Doppler LIDAR system that is capable of detecting wake vortices and wind shear phenomena of the order of 50-100 metres in front of an aircraft allowing action to be taken to reduce or avoid the hazard.
- The aim of the project is to develop a system suitable for integration into a commercial aircraft, but also to look at how data are to be presented to the aircrew.
- The main products from the project are: 1) a simulator which will allow the investigation and optimisation of the system which is to be built; 2) the system itself which will be designed, built and evaluated within the project.
- Further information on the project and contact details can be found on the Green-Wake project website at www.greenwake.org. The Green-Wake consortium would welcome comments from and contact with anyone interested in the project.

Contact: Lesley Hanna [LHanna@hovemere.com]

Green-Wake – Project Status

- The work to date has centred around using modeling techniques to understand how a LIDAR can be optimised to permit detection of wake vortex and wind shear events and researching the constraints and requirements under which the detection instrument must operate.
- The partners have looked at the meteorology, air traffic management aspects, aircraft installation, the system performance and flight control aspects in order to capture all the requirements which affect how the instrument must perform.
- **Year 1 (Nov. 2008 – Nov. 2009):** Work has started on some of the components of the LIDAR instrument which must be developed beyond the level of currently available technology in order to deliver the required level of performance.
- **Year 2 (Nov. 2009 – Nov. 2010):** A working, experimental version of the instrument will be built by the end of the second year of the project.
- **Year 3 (Nov. 2010 – Nov. 2011):** A programme of measurement to validate the instrument concept will take place in the final year of the project. A public seminar will be organised to share the results, promote discussion within the wake vortex community and to solicit comments and inputs for further work.

FLYSAFE - Concept

- FLYSAFE is a more than five-year EC Integrated Project of the 6th Framework Programme.
- FLYSAFE focuses on the areas identified as the main causes of accidents around the world: loss of control, controlled flight into terrain, and approach and landing. It will address the three types of threats: atmospheric conditions, traffic collision and terrain collision.
- FLYSAFE aims to enable all aircraft to get timely, dedicated, improved weather information via Weather Information Management Systems (WIMS) which gather, format and send to the aircraft routine weather data and information on adverse weather like thunderstorms, in-flight icing, CAT conditions, as well as information on aircraft wake vortices.
- This is achieved by the development of ground tools to predict, format and transmit meteorological information to aircraft on demand, taking the expected aircraft trajectory into account. On the aircraft this information will be combined with data from atmospheric probes.
- FLYSAFE demonstrated the functionality and applicability of an airborne Wake Encounter Prevention System.
- FLYSAFE designed, developed, implemented, tested and validated a complete Next Generation Integrated Surveillance System (NG ISS).
- For more information visit: http://www.eu-flysafe.org/EU-Flysafe_Public/Project.html

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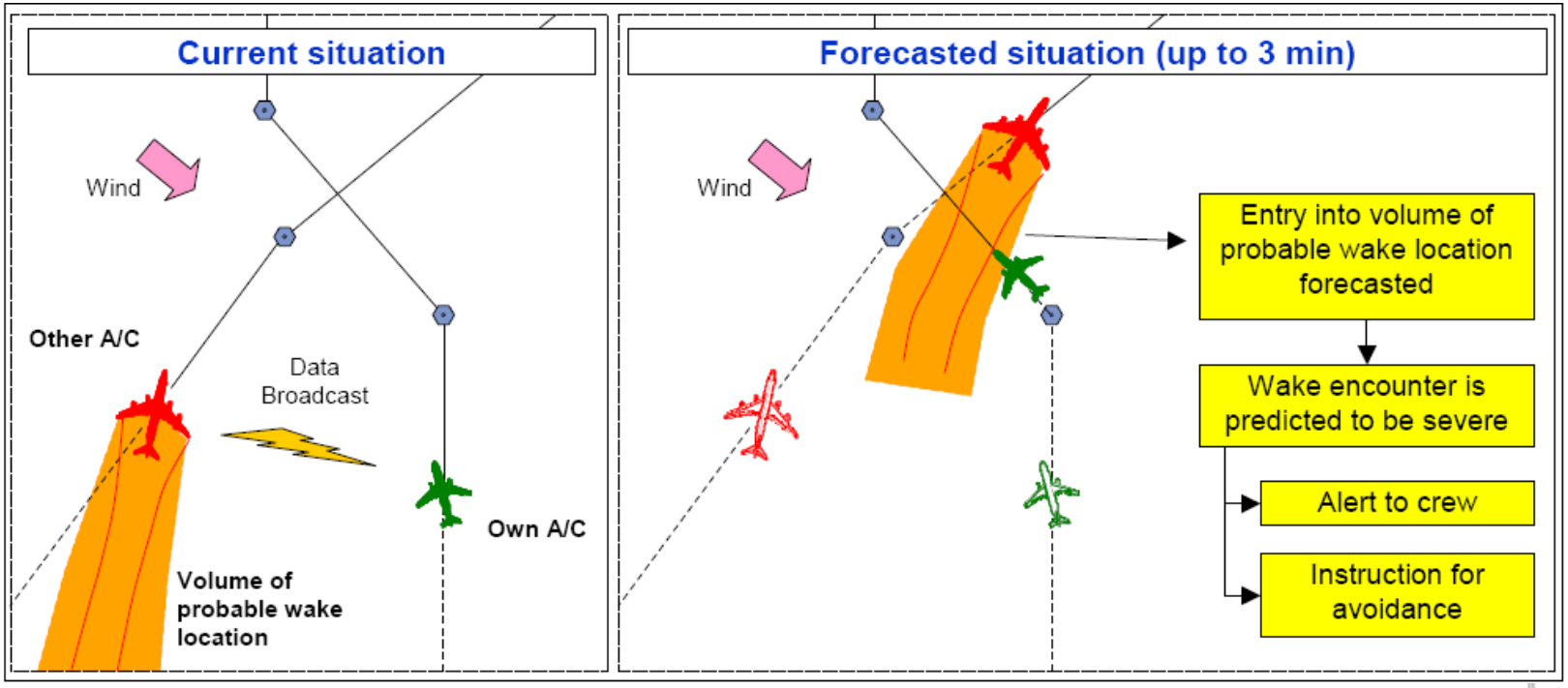
FLYSAFE – Concept Illustration of On-board Wake Prediction & Alert

- FLYSAFE will demonstrate the functionality and applicability of an on-board sensor for wake detection (LiDAR or RADAR technology).
- This will include on-board prediction of wake location and characteristics using:
  - Data input from own A/C, other A/C (e.g. through ADS-B) and WIMS.
  - Models to predict 3D wake evolution up to cruise altitude.



FLYSAFE – Project Status

- The functionality of Wake Vortex WIMS (TMA mode, ground system) was demonstrated at Frankfurt Airport in Winter 2006/2007:
  - Stable prediction characteristics - no forecast breakdowns.
  - Potential ("weather-wise") use of new ConOps in 75% of the time.
  - Potential capacity gain > 4 % (real traffic flow and traffic mix).
  - The predictions were correct: no warnings from the LIDAR from a-posteriori analysis of ≈1100 heavy aircraft approaches.
  - Controllers confirmed the benefit of such a system and agreed with the proposed procedures and display layout.
- FLYSAFE is now in the final phase (final forum held in March 2009 and final review in June 2009). The main activity over the last six months has been the Main Task Evaluation of the NG-ISS at the NLR GRACE and NARSIM simulators.
- The wake vortex elements of FLYSAFE (ground weather information management and onboard wake advisory system) were evaluated separately on Airbus THOR simulator in Hamburg in 2007-08.
- Future work: FLYSAFE concepts will be continued under the national project in Germany (Weather and Flying) and there are some flight test campaigns to be performed under the SESAR framework (WP6 and 12).

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Wetter & Fliegen (Weather & Flying) – Concept

Deutsches Zentrum für Luft- und Raumfahrt e.V. in der Helmholtz-Gemeinschaft

- Weather & Flying is a four-year project of DLR, which started in January 2008.
- The two key aims of the project are:
  - To provide timely, tailored and concise meteorological information, especially for adverse weather, to ATC, airline operating centres, pilots and airports.
  - To build automated flight control systems and design evasion-manoeuvre methods to minimise the impact of adverse wind & wake conditions on aircraft.
- Detection and forecast of weather phenomena (including wake vortices) will be achieved by setting up an Integrated Terminal Weather System (ITWS) at Frankfurt & Munich airports.
- Weather & Flying will continue development of DLR's **WSVBS** wake vortex advisory system.
- WSVBS supports **dynamic adjustment of aircraft wake vortex separations** dependent on weather conditions and the resulting wake behaviour without compromising safety. This aims at a tactical increase of airport capacity for approach and landing.
- WSVBS uses prediction tools and dedicated meteorological information. Wake vortex prediction is conducted with the Probabilistic Two-Phase (P2P) wake vortex decay model.
- A LIDAR monitors the correctness of WSVBS predictions in the most critical gates at low altitude.

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Weather & Flying/WSVBS – Project Status

Deutsches Zentrum für Luft- und Raumfahrt e.V. in der Helmholtz-Gemeinschaft

- WSVBS (the WV WIMS - TMA mode in FLYSAFE jargon) demonstrated its functionality at Frankfurt Airport from 20/12/06 – 28/02/07.
- It was integrated into the AMAN of DLR and every 10 minutes delivered safe aircraft separation times for the next hour.
- WSVBS will be expanded, optimised and fully automated in Weather & Flying as **advanced-WSVBS** (A-WSVBS).
- The planned activities for A-WSVBS in Weather & Flying are:
  - Preparation for implementing A-WSVBS at an airport.
  - Risk analysis and assessment of capacity gain of A-WSVBS.
  - Proposal for re-categorisation of aircraft according to wake vortex separation.
  - A-WSVBS will be integrated into the ITWS and demonstrated in a campaign at Frankfurt or Munich in 2010.
  - Components of A-WSVBS will also to be developed and tested within a project of the SESAR-Joint Undertaking.
- The elements of WSVBS are generic and can be adapted to other runway systems & airports.
- For more information visit: http://www.pa.op.dlr.de/wirbelschleppe/

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If you have any questions about the content of this bulletin please contact Debbie Mitchell at:

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Alternatively, for more detailed information about one of the wake vortex concepts featured, please contact the technical leader for the concept listed.

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