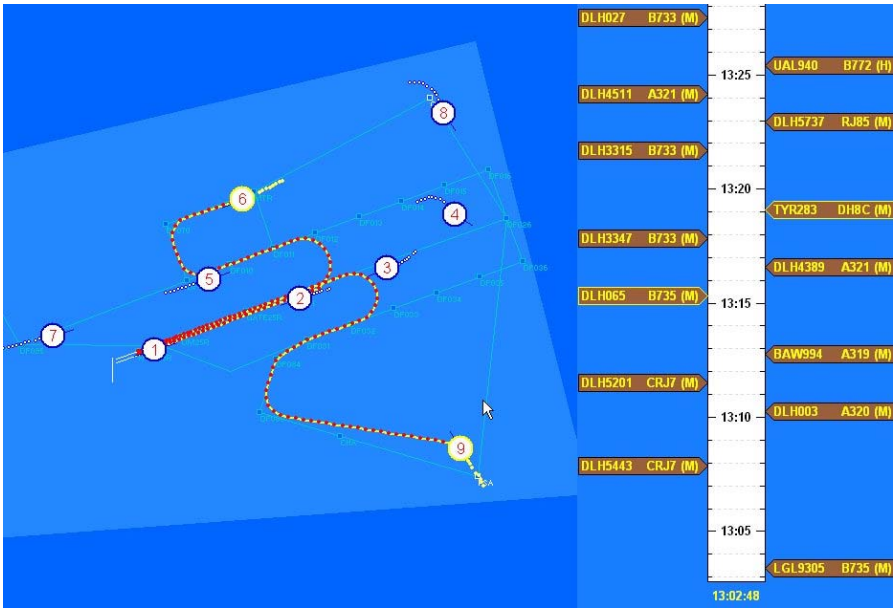
INSTITUTE OF FLIGHT GUIDANCE

DLR 4D-CARMA
(4 Dimensional Cooperative Arrival Manager)



Trajectory based Approach by 4D-CARMA

Constantly increasing traffic at airports is the reason for air traffic service providers at big hub airports to look for computer-based systems supporting the controllers to improve the utilisation of the available resources. Controllers managing the inbound traffic perform the following tasks:

1. Build an arrival sequence.
2. Assign an (absolute or relative) arrival time at the runway threshold (and other significant waypoints) to each aircraft in the sequence.
3. Predict a trajectory for each aircraft which implements the assigned landing time.
4. Transform the trajectory into appropriate guidance instructions which are transmitted to the pilot via voice or data link.

Arrival Managers (AMAN) which claim to support the controllers have to match with fulfilling these four tasks. The development of AMANs has a long tradition in the **Institute of Flight Guidance, German Aerospace Centre (DLR).** Uwe Völckers started the design of COMPAS, the forefather of all Arrival Managers in the early 80's. It was brought into operation at Frankfurt Airport. COMPAS already facilitates the first and second task by building an arrival sequence based on flight plans and early radar information. The COMPAS system introduced the time line as controller interface to display the arrival sequence and planned landing times. COMPAS, however, fixed the sequence at a very early stage.

Since 2003 its successor, the 4D-Planer, being developed in close cooperation of DLR and DFS, is in operation at Frankfurt Airport. It improves the sequence planning task by constantly considering the actual radar data. The 4D-Planer is therefore able to adapt the schedule of arrivals to any ATC control action, even if this action deviates from the proposed plan. COMPAS, 4D-Planer and other AMANs currently in operation do not consider an appropriate advisory generation based on predicted trajectories. The Institute of Flight Guidance is currently developing the prototype **4D-CARMA** with the following additional features:

- It generates trajectories from aircraft position to the runway threshold, taking into account weather conditions and aircraft performance data (BADA).
- It generates guidance instructions for voice or data link communication.
- Trajectory-based guidance comprises features for conformance monitoring, conflict detection, and resolution.
- The sequence generation is based on optimisation of several, partly contradictory evaluation criteria, e.g. the comparison of two sequences with respect to their noise profiles in the TMA.

The future success of an AMAN will mainly depend on its integration with other controller decision support tools to achieve a smooth and efficient inbound flow whilst maintaining an optimal runway utilisation and taking into account airline preferred trajectories. Therefore **4D-CARMA** addresses:

- The horizontal cooperation with DLR's departure manager and a wake vortex prediction system.
- The vertical cooperation with DLR's EFMS (extended 4D flight management system) as a first step to trajectory based air-ground cooperation.
- The hierarchical cooperation with DLR's pre-tactical TOP (Total Operations Planner).

DLR