A SMOOTHER RHYTHM

Today, for economic, environmental, regulatory and capacity reasons, all airports are concerned about traffic optimisation in terminal manoeuvring areas

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Capacity at airports has long been identified as the primary limitation factor of the overall ATM system. Despite short-term economic fluctuations, the air traffic growth trend leads many approaches and airports to congestion. According to projections, demand is still expected to have doubled by 2025, bringing about economic, financial and environmental concerns. This situation wreaks havoc in terminal areas, producing holding delays for arrivals and long queues at the runway threshold for departures. These effects put a heavy burden on controllers and potentially jeopardise safety. In addition to this, they cause dismal consequences for all aviation stakeholders such as degraded turnaround and fuel waste.

Figure 1: MAESTRO HMI showing the delay caused by runway closure

In this context increasing airport capacity is a critical element driving the evolution of ATM systems. More than ever, integrated arrival and departure management is recognised as a key solution to eliminate gridlocks in the air and on the ground and to address cost-effectiveness and green issues.

To tackle these challenges, some airports have already successfully experienced benefits in using MAESTRO for several years. MAESTRO, a product co-developed by Egis Avia and the French Air Navigation Service Provider (DSNA), offers a fully integrated AMAN/DMAN solution for automated support of arrival, departure and runway management.

Regarding arrival congestion, area control centre (ACC) controllers usually report no problem and thus expedite the traffic to the approach (APP). In this scenario APP controllers do not have a reliable picture of traffic and discover the capacity problem rather belatedly. This situation often results in protective APP capacity, which tends to magnify consequences such as an urgent use of holding pattern, a tricky coordination with ACC and stress for controllers.

To accommodate arrival flows, the MAESTRO AMAN function provides support to controllers to properly expedite the incoming traffic to the managed airports and runways and assists them by indicating the optimal separation for flights on final approach. It helps to manage a linear delay instead of using holding patterns. Current operational installations of AMAN have measured capacity gain, reduction of fuel consumption while improving the safety level of arrival operations.

Usually airports do not master departure flows due to a lack of reliable departure forecast or diverse and variable taxiing times, which cannot be handled by tower controllers. The difficult adherence to air traffic flow management (ATFM) regulations is also a potential cause. In such a context, ground-runway controllers will try to optimise the runway capacity and thus expedite departures regardless of en-route constraints. This entails no predictability over traffic, low anticipation and no coordination for ACC departure sectors as departures are often discovered after take-off and might converge to the same SID exit points. Once again, these pernicious effects fall upon controllers and possibly increase their stress.

MAESTRO DMAN provides controllers with suggestions (Runway, Holding Point and SID) and alerts to manage departure streams according to various airport configurations. It shares a target take-off time at airport level and feeds the departure runway with a relevant number of aircraft. If necessary the aircraft waits at the stand to prevent runway incursions and long taxiing phase. It compiles the constraints from regional air traffic flow and capacity management (ATFCM), the local airport collaborative decision making (A-CDM) process and satellite airports. The system aims at building a departure sequence while minimising aircraft queues and enables consequently an optimum use of the airport's capacity.

Beyond saturation issues, the global economic downturn highlighted the need for a cost-effective air-transport system. The recent crisis has placed increased pressure on its stakeholders. Implementing solutions to cut costs, increase profitability and optimise operations is high on their agenda. At the same time, environmental concern is on the rise, magnified by the growing footprint of increasing air traffic. Offering an integrated solution for arrival and departure management, MAESTRO makes these requirements compatible and provides a solution addressing these critical issues.

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MAESTRO goes further with the optimisation of capacity management by offering AMAN/DMAN integration relying on:

- A modular client-server architecture allowing configurations (standalone/integrated into a wider ATM system);
- Easy and cost-efficient implementations through the sharing of machines, external connections and basic technical processes for enhanced performance;
- A shared runway configuration management and planning allowing a mastered distribution of arrival and departure flows on the runway system;
- A state-of-the-art HMI merging departure and arrival flights on the same time line views, taking account of human factors principles for safe and efficient interactions;
- An off-line graphical configuration tool enabling fast and intuitive learning for operational and technical staff.

The MAESTRO AMAN/DMAN integration turns out to be particularly efficient at mitigating airport airside congestion and delays at a regional scale as it enables a unified management of the terminal manoeuvring area (TMA) configuration, with a possible extension to five independent TMAs.

In addition to these major functionalities and beyond the significant payoffs offered in terms of airspace and runway optimisation, MAESTRO also addresses environmental issues by providing a better management of trajectories, thus reducing fuel consumption, CO_2 and noise emissions.

Worldwide solutions

MAESTRO qualities have made it the most widely used sequencing and metering system in the world. Since 1996, when the first AMAN system was operationally used in Copenhagen, Egis Avia has deployed MAESTRO in 17 major airports in nine countries and further developed the product to support its customer base.

The integration of the new departure management function of MAESTRO is ongoing and will be installed at Paris CDG early 2010. Dedicated prototyping sessions enable tuning of the new HMI and procedures for delivery, supervisor and apron positions. This collaborative approach of the project is a key success factor to getting the support of end users.

Egis Avia's long-standing experience in commissioning operational AMAN systems is enhanced by participation in major European R&D projects. In 2005 MAESTRO was connected to Eurocontrol's test platform in Bretigny to run traffic simulations at the Paris area scale. It was the largest simulation ever run in Europe and MAESTRO demonstrated its capacity to handle the heavy traffic forecasted for 2015 in Paris-Orly and Paris-CDG TMAs.

In 2005-2006, MAESTRO was integrated into the DSNA DAARWIN platform of the gate-to-gate project in support of real-time simulations to assess the combination between AMAN, ASAS crossing and merging and advanced HMI for arrival sectors.

In 2006-2008, MAESTRO was connected to a THALES EUROCAT-tower system at Toulouse-Blagnac Airport for the EMMA2 project, paving the way for interoperability between DMAN and A-SMGCS. In 2007-2008, for the ASPASIA project, MAESTRO was connected to an Egis Avia SCANSIM ATC simulator to assess the benefits of aircraft derived data for the arrival management function.

For the ongoing MINT & CASSIS II projects, MAESTRO is being adapted to use aircraft FMS data to support controlled

time of arrival [CTA] operations. MAESTRO will also be involved in several SESAR projects in the coming years thanks to its valuable operational experience and background and to its considerable technical agility to cope with emerging needs.

Open collaboration

In Europe the SESAR programme defines a new framework for the coming decades to move the concept of operations towards a more collaborative way involving airspace users and taking advantage of the new technologies available. This concept is organised around the key notion of trajectory-based operations, which considers the aircraft path from a gate-to-gate perspective. This new paradigm implies the effective integration of airports in the loop and requires improved capacities (scheduling, demand and capacity balancing, and runway throughput) together with enhanced collaborative decision-making mechanisms. Collaboration is not possible without a shared flight schedule.

Advanced sequencing and scheduling tools are intended to handle the available traffic data and enable the setting of capacities, airport configurations and strategies for up to three hours ahead. These planning tools dramatically improve the predictability of the estimated touch-down or wheel-up time, thus enabling an optimisation of the turnaround process of the airport. The predictability and the accuracy of the departure and arrival segments of the trajectories are of paramount importance in the economy of airlines and are key enablers for managing business trajectories.

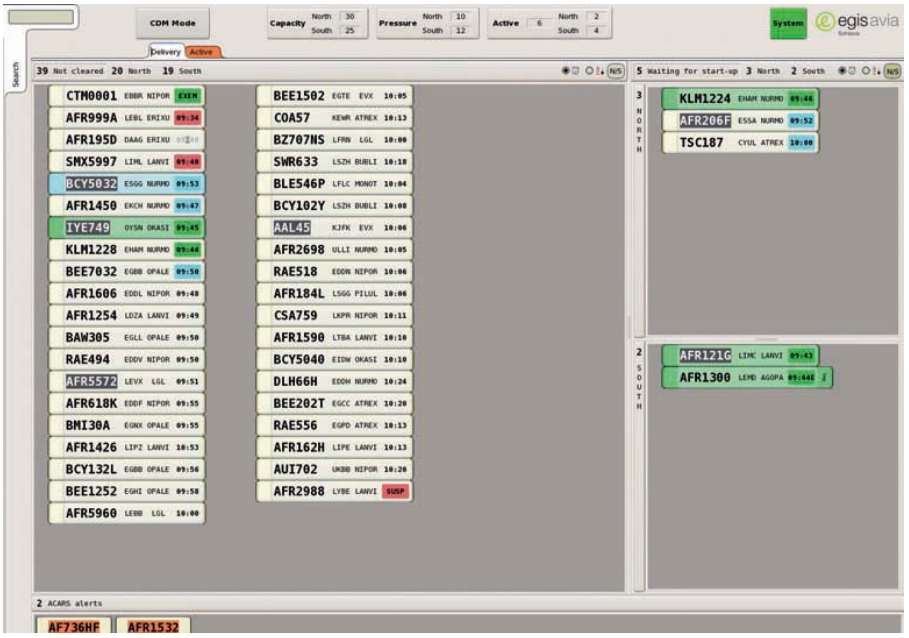

Figure 2: MAESTRO Delivery HMI with flights waiting for the start-up clearance

Advanced arrival and departure

Beyond the capabilities of the basic AMAN tool, new procedures are envisioned by disseminating arrival information to all stakeholders in order to improve the service regarding arrivals for a TMA. As a good example of this, the planned airport configuration (runway in use) has the ability to reduce uncertainty regarding the aircraft trajectory entered in the FMS before its departure.

Advanced negotiation of the arrival segment will allow selecting a green approach (continuous descent approach/arrival) before the top of descent. This negotiation cannot be performed by a single control sector or a single human operator: machine-to-machine dialogues must prepare an acceptable and relevant proposal prior to the pilot-controller agreement. The same user-oriented philosophy is also considered for departures in order to improve the turn-around process via an A-CDM process to synchronise pre-sequence at the block.

The departure service must be extended to the SID exit point in order to follow up a capacitive and green system for departures. Continuous climbing trajectories shall be used as much as possible and departure flows shall be split on various exit points to prevent congestions in outbound sectors. MAESTRO opens the way to a long-term perspective and already supports most of its key concepts by encompassing arrival, departure and runway-use management.

Consolidated roadmap

After a first step of integration of arrival and departure functions into a single system, the MAESTRO Users Group has recently

SIGNIFICANT GAINS AND RETURN ON INVESTMENT FOR DEPLOYED SITES

Airport	Country	Gain
Paris CDG	France	Nominal TMA capacity is reduced by 30 percent if MAESTRO is not available (occurred once in 2001)
Copenhagen	Denmark	Runway capacity has been increased by 15 percent
Sydney	Australia	12 months after the operational use of MAESTRO in 2000 for the Olympic Games, about A$7.1 million of fuel consumption have been saved
Stockholm-Arlanda	Sweden	Increased capacity and efficiency for airlines due to less time in holding and shorter routes

Maestro also addresses environmental issues by providing a better management of trajectories

confirmed the product roadmap to be completed in further versions by advanced features addressing new ATM concepts:
• The trade-off between arrival and departure flows will be balanced by adjusting runway rates (for departure and arrivals) via a new probing function. Controllers will assess the impact on arrival and departure sequences against key performance indicators such as the global delay for departures and arrivals for each airport.
• The departure sequence will take more constraints such as TMA constraints but DMAN will cope with the AMAN delay to be reabsorbed on the ground.
• Improvement of the turn-around process during adverse conditions will be addressed by integrating the de-icing management of the DMAN within the airport systems.

To conclude, AMAN/DMAN concepts are clearly identified as key enablers for the next-generation ATM system envisaged by the ICAO Global ATM Concept and regional application programmes such as NextGen and SESAR. MAESTRO, with its continuous development and improvements, will widely contribute to this impetus by offering a system conciliating *a priori* antagonist concepts such as capacity increase and environmental sustainability. ❖