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OPERATIONAL CONCEPT OF ARRIVAL MANAGER

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Abstract. *In this article is analyzed the conceptual structure of AMAN, namely the topicality and history of creation of this conception, principles and availability for usage of this concept for the purpose of improvement of air traffic control. We reviewed ways of AMAN usage on examples of arrival and departure aircraft and determined major advantages and necessity of conception implementation.*

Keywords: AMAN**;** arrival; efficiency; operability.

1. Introduction

Nowadays, with continuous growing of air traffic, it is necessary to find solutions how to control the big air flow in more effective way. One of the solutions is the “Arrival Manager” (AMAN), system which arranges arrivals more safely and effectively. This concept interacts with some features which are showed in Figure 1, to achieve maximum effectivity.

Arrival Management systems (AMANs) have been developed in Europe over the course of many years. Without a centralized or standardized approach, these systems, including their related procedures and methods of implementation, have developed somewhat independently. As such, these systems are now used in slightly different ways in different locations.

To organize this system correctly it is necessary to consider some different elements like place features, system structure and others. These elements can impact the system, so they can’t be avoided. To assist in the arrival management process, several aids and support are already available and being used. These can range from simple pieces of paper (such as flight-schedule printouts, or flight-progress strips arranged in sequence on a flight-progress board), to electronic aids, where simple arrival information is presented to those air traffic controllers (ATCOs) handling the flight.

At the top of the range sits dedicated software functionality, which not only assists in sequencing and optimising the flow of arriving flights, but also provides information (or advisories) to the ATCOs on what is needed to create and maintain the arrival sequence.

2. Analysis of the latest research

The aviation industry has been developing Arrival Manager systems and tools to assist air navigation service providers (ANSPs) in their own needs. In some areas AMANs are used and regarded as essential sequencing aids, providing robust support for the ATCOs sequencing traffic to an airport. In other locations they are used primarily as “metering” tools, mainly used for regulating the flow of traffic into the TMAs surrounding busy airports. In yet other implementations they fulfill a traffic awareness role, or are used for coordination purposes. In some areas, they occupy only a background role for most of the time, working but not really “used”. More detailed research is described in AMAN Status Review 2009 document [1].

With the help of AMAN ANSPs are assisted with aircraft arrivals, particularly during challenging periods such as bad weather or runway closures. AMAN provides electronic assistance in the management of the flow of arriving traffic in a particular airspace, to particular points, such as runway thresholds or metering points, which is the main objective of this system. Its main aims are to assist the controller to optimize the runway capacity (sequence) and/or to regulate/manage (meter) the flow of aircraft entering the airspace, such as a terminal control area (TMA). It also aims to provide predictability for its users (both ground and air) and at the same time minimize the impact on the environment, by reduced holding and low-level vectoring.

To meet these objectives, the AMAN system provides a sequence at the runway, and also provides an expected or scheduled time for each flight at the runway or at/over different fixes.

Fig. 1. AMAN Integration

The AMAN is biased towards linear delay absorption instead of orbital holdings, aiming to assist in eliminating low-level orbital holding, or at least reducing holding on arrival to a minimum. The planning and/or sequencing function of the AMAN also aims to reduce controller workload, particularly in case of perturbations (such as runway closure). The AMAN itself is usually managed by a dedicated controller (such as, a "Supervisor" or "Manager" in Approach) and the computed information can be distributed in Approach sectors and also upstream to area control Centre (ACC) sectors and other centers [2].

In general, AMAN helps to assist in managing of air flows combining such factors as safety, environment, efficiency, capacity because they may act in opposite directions when we will improve one of them.

3. Principles of operation

The AMAN system interacts with several systems, including the host Flight Data Processing System (FDPS) and Radar Data Processing System (RDPS). It uses a combination of flight-plan information, radar information, weather information, local airspace and route information, and an aircraft performance model in its trajectory prediction, resulting in a 'planned' time for any individual flight this is described in Figure 2.

Since the AMAN has certain conditions it needs to satisfy (such as the required landing rate, or spacing, on the runway), when 2 or more aircraft are predicted at or around the same time on the runway it plans a sequence, generating new 'required' times that need to be applied to the flight(s), in order to create/maintain the sequence [4].

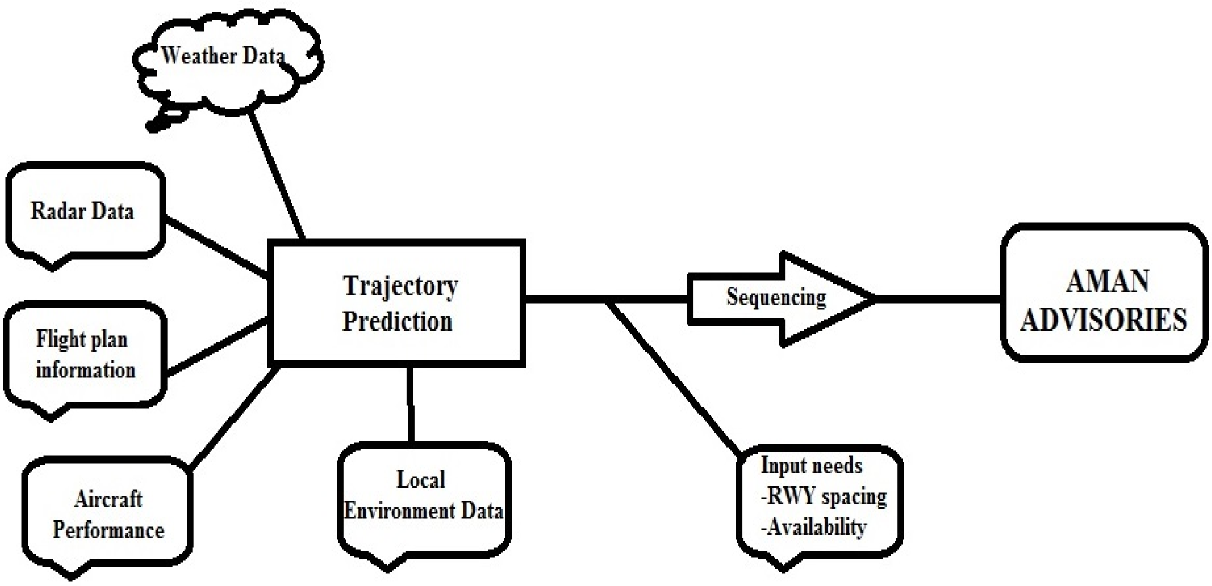

Fig. 2. AMAN functionality

The system utilizes an aircraft performance model and it is also fed with known airspace/flight constraints, such as speed restrictions (e.g. 250kts below FL100 (flight level)) to be used in the calculation of predicted times and aircraft trajectories. Wake Turbulence Category information is also taken into consideration. Weather information (wind) is also usually made available to the AMAN, to assist in more accurate flight prediction. Manual inputs to the AMAN include insertion of the landing rate or separation on final and/or the cadence of landing for a runway, or "slots" to block a runway for a specified length of time. An AMAN system may also take into consideration prescribed optimization criteria. Processing phase: In the initial phase, a trajectory prediction process delivers an estimated time (unconstrained) for a flight, at a particular point (runway threshold, TMA (terminal control area), entries, IAF (initial approach fix or feeder-fixes). This process uses either an AMAN-internal or an "external" trajectory predictor, such as the trajectory predictor in the FDPS. The sequencer element of the AMAN then builds a global sequence, which generally integrates the flow of traffic on a "first come, first serve" principle, although other principles may also be applied, such as equity, distribution of delay, and wake category grouping.

This then results in a scheduled sequence and with a scheduled (constrained) time for each aircraft. These times – "constrained" (taking into account all arriving traffic) and unconstrained (aircraft considered alone in the sky) - are then compared and "delay information", if applicable, is provided as an output of the system.

Generally, AMANs have several defined horizons, during which flights are recognized/captured, planned, sequenced, re-sequenced if necessary and then ultimately frozen in the arrival process. A position in the sequence is frozen only when the flight has entered a stable horizon. The location or distance from touchdown for these horizons is a matter for local implementation. Some systems operate dynamically (with constant updates) until quite late in the flight. The basic process is summarized in the following Figures 3,4 and short "generic" scenarios:

1. Around 150-200nm from touchdown, the aircraft is captured. This distance is often called the AMAN horizon

2. On the ground, the AMAN system computes the aircraft's preferred Arrival Time

3. The flight is then sequenced in the flow of traffic, in function of its computed preferred Arrival Time and sequencing criteria

4. The AMAN system displays notifications and advisories to the ATCO, who uses them to sequence the aircraft (via R/T)

5. The aircraft follows the instructions given by the ATCO

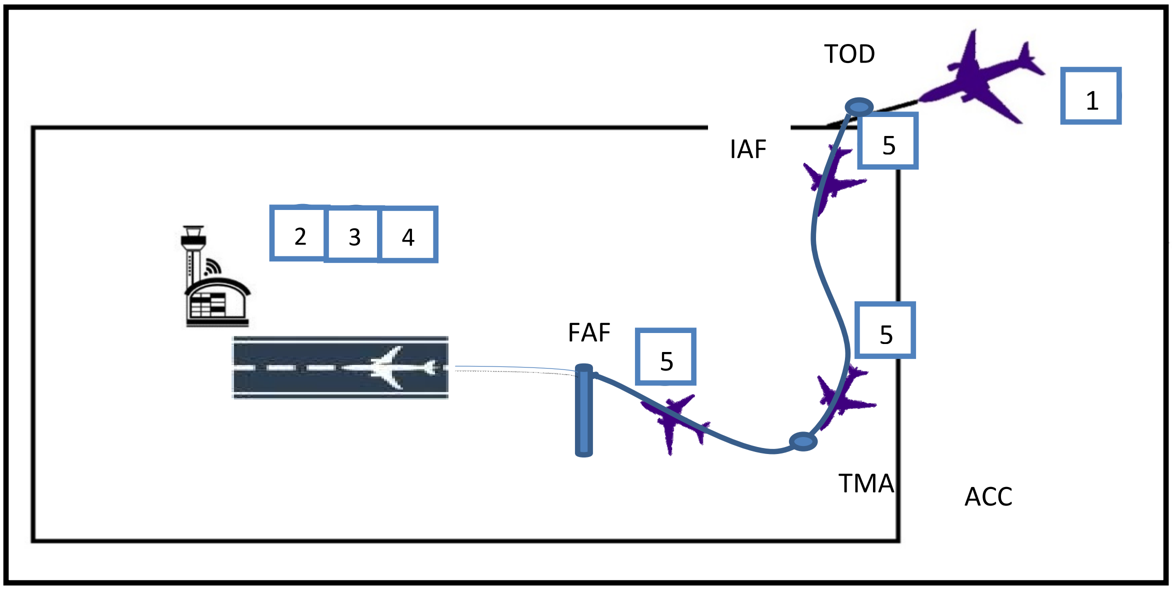

Fig. 3. AMAN system (lateral view)

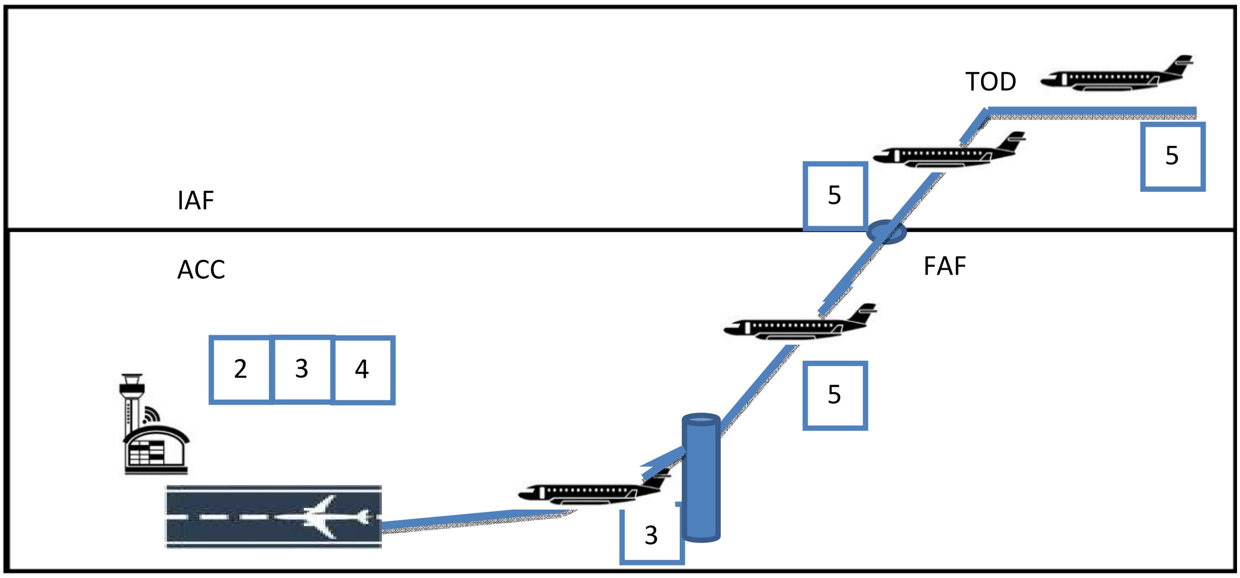

Fig. 4. AMAN system (vertical view)

Managing the AMAN system:

Generally an AMAN supervisor manages the AMAN. He/she sets and adjusts landing rates, handles runway closures/switches and also other perturbations (go-around, aircraft proceeding to diversion airport during the approach…). The AMAN manager is usually responsible for changes to the sequence, swapping 2 or more aircraft as needed. He/she is also generally responsible for manually reserving slots for pop-up traffic, traffic originating within the AMAN horizon.

Operations of the AMAN system:

Although the AMAN supervisor is usually responsible for interacting with/monitoring the progress of the flights in the AMAN, it is the sector ATCO who remains in charge and who is responsible for the tactical application of any delay, and for the overall control/safety of the flights concerned.

Acceptance of the AMAN system:

The use of the AMAN varies somewhat from ACC/APP (approach control center) to ACC/APP, and its acceptance and use by controllers also varies from ATCU (Air Traffic Control Unit) to ATCU. In some cases the AMAN is left operating relatively passively in the background, whilst in other areas the AMAN has become such an integrated part of the daily routine that its unavailability can lead to reduced acceptance rates [3].

4. Conclusions

In modern aviation there are many problems that must be solved. One of them is a big amount of traffic near the aerodromes. AMAN is the system which is created to solve this problem. Nowadays AMAN is using in many big airports and helps to regulate air flows in more efficient and effective way.

The system controls the amount of traffic entering the TMA. AMAN links the different arrival streams to a complete picture. The process is dynamic; the planning is steadily adjusted to the radar situation. However, controllers have the opportunity for manual inputs (e.g. sequence changes, or manual runway assignment) at any stage.

AMAN is very useful at a constant flow of traffic; however controllers at times find it difficult to handle it in special or frequently changing situations, such as adverse weather conditions (e.g. thunderstorms) or sudden runway closures.

References

[1] EUROCONTROL – AMAN Status Review 2009. Edition: 0.2. Date: 17th February 2010. Status: Proposed Issue.

[2] EUROCONTROL – AMAN Status Review 2010. Edition: 0.X. Date: 17th December 2010. Status: Proposed Issue.

[3] EUROCONTROL - "Arrival Management Multi-Airport and Cross-Border Issues Capture". Edition: 1.0. Date: August 2009. Status: Publicly available.

[4] http://www.skybrary.aero

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У статті проаналізовано концептуальну структуру AMAN, а саме актуальність та історію створення цієї концепції, принципи та можливість її застосування для покращення ефективності управління повітряним рухом. Розглянуто шляхи використання AMAN на прикладах повітряних кораблів, які прилітають та вилітають. Визначено основні переваги і необхідність впровадження цієї концепції.

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В статье проанализирована концептуальная структура AMAN, а именно актуальность и история создания этой концепции, принципы и возможность её применения для улучшения эффективности управления воздушным движением. Рассмотрены пути использования AMAN на примерах прибывающих и убывающих воздушных судов. Определены основные преимущества и необходимость внедрения этой концепции.

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