AEROSPACE SYSTEMS FOR MONITORING AND CONTROL

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CONCEPT OF AIR TRAFFIC FLOW AND CAPACITY MANAGEMENT IN EUROPEAN REGION

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Abstract. *The article deals with the analysis of the researches conducted in field of the air traffic flow and capacity management by Eurocontrol. Traffic flows statistics, air traffic flow and capacity management phases and Enhanced traffic flow management system have been reviewed. Principles of concept implementation and impact on air traffic flow and capacity management have been analysed and general recommendations applicable for Ukrainian aeronautical system have been proposed.*

Keywords: Air Traffic Flow and Capacity Management; air traffic management; Central Flow Management Unit; Enhanced traffic flow management system; European Air Traffic Management programme; Integrated initial flight plan processing system; traffic flows statistics.

1. Introduction

The high-level view of Aeronautical System (ANS) performance in the wider context of air traffic operating under Instrument Flight Rules (IFR) in Europe addresses the key performance areas of the Single European Sky (SES) performance scheme:

– *Capacity/Delays:* Arrival punctuality improved significantly in 2011 (-6.2% pt.) reaching a level similar to 2009 with subsequent positive effects on the European network. ANS contributed through a substantial reduction in total Air Traffic Flow Management (ATFM) delays (-35%), mainly driven by a reduction of en-route delays (-42%) in 2011.

– *Cost-efficiency:* Total air navigation charges accounted for 6.2% of airlines' total operating costs in Europe. Despite a projected increase of total ANS provision costs by +1.8%, the costs per unit in Europe decreased notably in 2011, due to the increase in traffic (+3.1%). En-route ANS provision costs accounting for some 80% of total ANS provision are projected to increase by +2.3% in 2011 while terminal ANS provision costs are projected to decrease by -0.7%.

2. Traffic flows statistics and forecasts in European region

In 2011, IFR traffic grew on average by +3.1% in Europe but remains below the pre-economic crisis levels of 2007 and 2008 (Fig. 1).

Overall, there was a slow traffic recovery in 2011 as some of the observed growth is a compensating effect for the cancellations due to adverse events (ash cloud, strikes, weather) in 2010 [EUROCONTROL…2011, EUROCONTROL…2012, PRR 2010, PRR 2011].

Traffic growth is not evenly spread across Europe. High growth rates are observed in eastern European States (Ukraine, see Table) and this trend is forecast to continue between 2012-2015 (Fig. 2).

The Ukrainian 2008–2010 traffic statistics

Parameter	2008	2009	2010
Total IFR flights controlled	406	378	429
IFR flight-hours controlled	333	308	348
IFR airport movements controlled	192	165	185
Controllers	941	936	n/a

Overall, unit costs decreased notably in 2011, as a result of a decrease in total ANS-related economic costs (-4.3%) and a traffic growth of 3.1% which is a good achievement. The reduction results from a substantial improvement in ANS service quality compared to 2010 and thus from a reduction of ANS-related service quality costs of -13% which compensated for the increase in ANS provision costs (+1.8%).

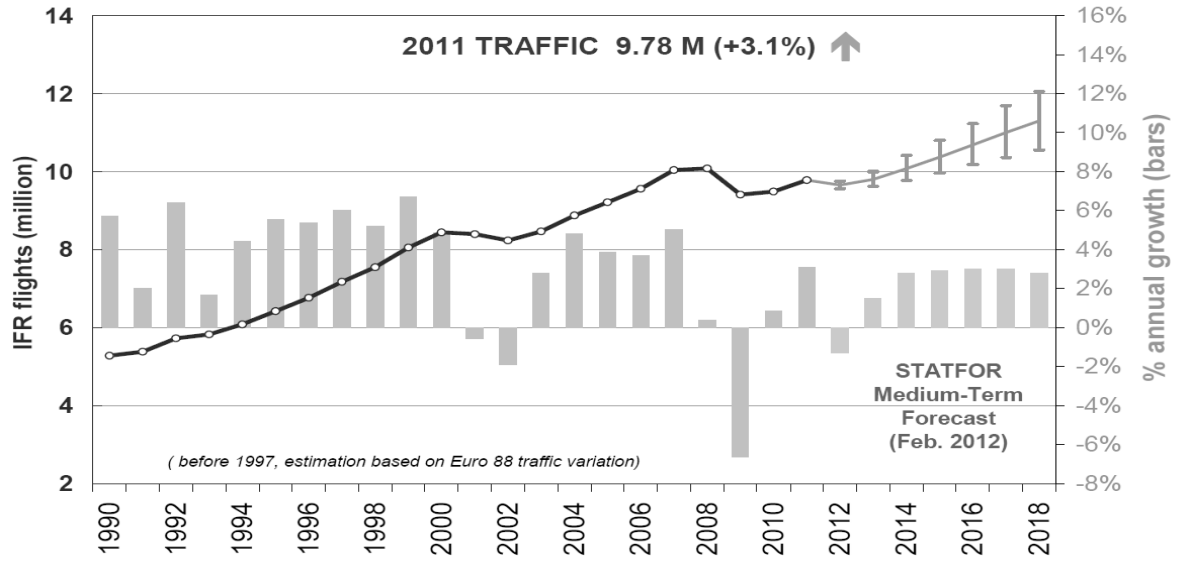

Fig. 1. Traffic flows statistics and forecasts in European region

3. Central flow management unit structure and functions

The creation of the Central Flow Management Unit (CFMU) was decided by the Transport Ministers of the European Civil Aviation Conference (ECAC) States in October 1988. The Member States of ECAC asked EUROCONTROL to create and operate on their behalf the CFMU which was mandated to provide Air Traffic Flow and Capacity Management (ATFCM) services throughout their airspace.

Then, in January 2011, the CFMU Directorate was integrated into a wider EUROCONTROL unit: the Directorate Network Management (DNM), which aims at ensuring the Network Manager function. The operational part of the former CFMU Directorate forms part of this new DNM directorate and has been renamed: CFMU Network Operations.

The Network Operations Unit is responsible to the DNM for Planning, Coordination and Execution of the Strategic, Pre-Tactical and Tactical ATFCM within the area of responsibility of the CFMU.

The Network Operations Unit is responsible for collecting, maintaining and providing data on flight operations and on the air navigation infrastructure as required for the national Air Traffic Control (ATC) systems and the CFMU systems in the different Phases of the ATFCM operations.

The role of CFMU Network Operations Unit can be illustrated by the main processes for exchanging operational information across the Network, as described on Fig. 2.

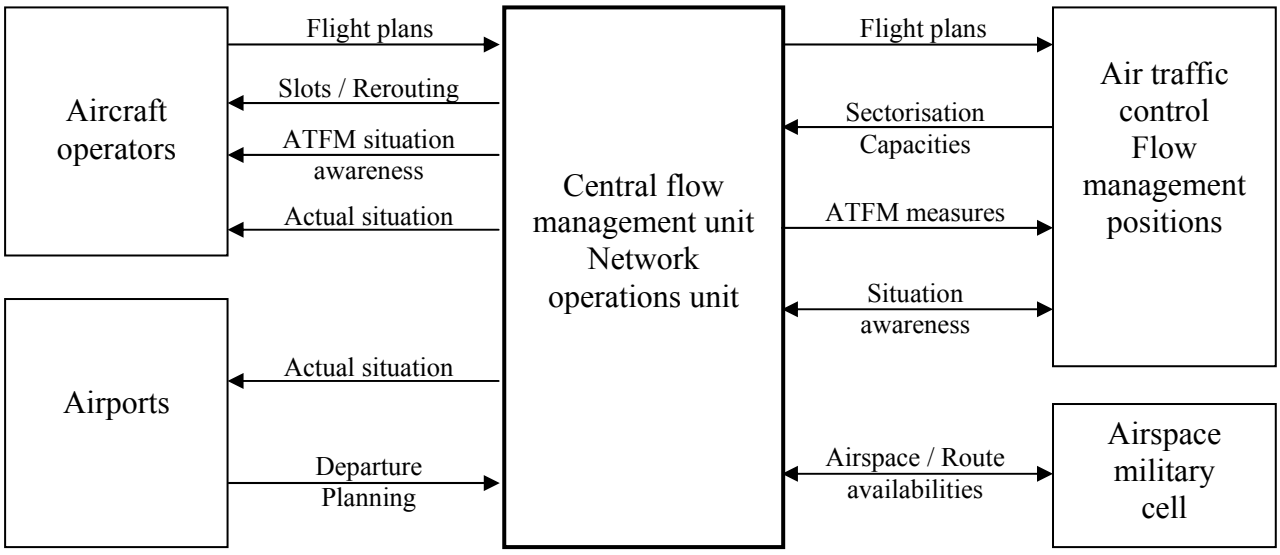

Fig. 2. Operational Structure with CFMU Network Operations Unit

The Network Operations Unit contributes to the overall Development and Management of the ATFCM component of the European Air Traffic Management (EATM) and to the Operations Consultation Group (OCG) activities.

The Primary Systems of the CFMU are [General…2011]:

– the ATS Environment System;
– the Repetitive Flight Plan System (RPL);
– the Integrated Initial Flight Plan Processing System (IFPS);
– the TACTICAL System (ETFMS);
– the Archive System (DWH or Data warehouse, formerly called ARC);
– the IFPS Validation System (IFPUV);
– the Pre-Tactical System (PREDICT).

Most data flow exchanged between CFMU and Users systems correspond to flight plan data (FPLs) and individual ATFCM measures (slot and rerouting messages). A general overview of the CFMU systems architecture can be found in the Fig. 3.

4. Air traffic flow and capacity management brief description

Air Traffic Flow and Capacity Management is at the core of Air Traffic Management (ATM) network operations. The purpose of ATFCM is to:

1. Manage the overall ATFCM Network in Europe and assist ANSPs to manage local capacity.
2. Aim to achieve balance between demand and capacity.

The objective of ATFCM is to optimise traffic flows according to ATC capacity while enabling airlines to operate safe and efficient flights.

The ATFCM activities are divided into three phases:

– *strategic phase* (about one year before the flight takes place until one week before real time operations. During this phase, the Network Manager Operations Center (NMOC) helps the Air Navigation Service Providers (ANSPs) to predict what capacity they will need to provide in each of their air traffic control centres. This also includes avoiding imbalances between capacity and demand for events taking place a week or more in the future);

– *pre-tactical phase* (six days before real time operations. The task of the NMOC staff is to: coordinate the definition of a daily plan aimed at optimising the overall ATM network performance and minimising delay and cost, after a collaborative decision making process involving operational partners; inform operational partners about the ATFCM measures that will be in force in European airspace on the following day via the publication of the agreed plan for the day of operations);

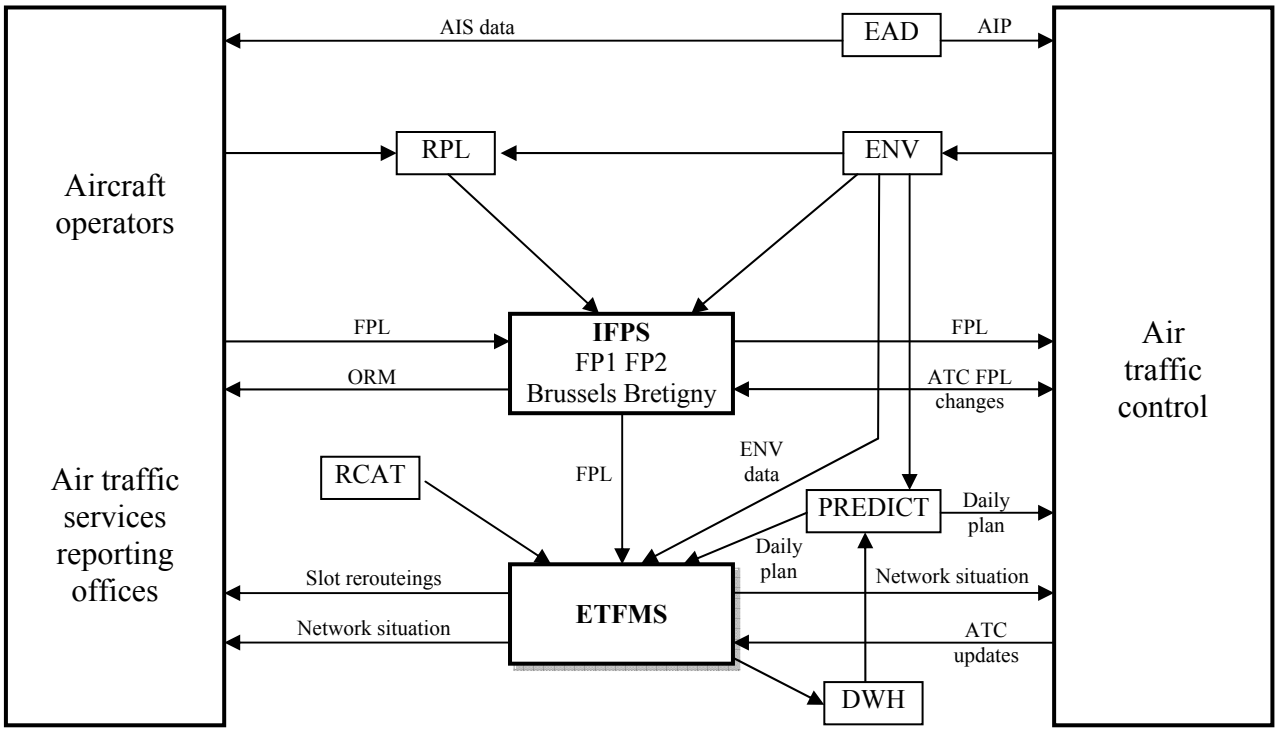

Fig. 3. CFMU Systems Overview

– *tactical phase* (the day of operations. The staff monitors and updates the Daily Plan made the day before based on current reality. The staff continues working on capacity optimisation according to real time traffic demand, and where aircraft are affected by a regulation, offers alternative solutions to minimise delays. Flights taking place on that day receive the benefit of the flow management service, which includes inter alia the allocation of individual aircraft departure slots, re-routings to avoid bottlenecks and alternative flight profiles in an attempt to maximise flight efficiency and make the best use of the available capacity).

Multiple means are available to perform ATFCM, from adjusting the demand to anticipating and optimising the available capacity.

ATFCM services include:

– Crisis & Contingency Management (tackling network disruptions and ensuring operational continuity);

– Daily Plan Preparation (develop the ATFCM measures to be implemented on the following day);

– Load and capacity management (constant monitoring of the ATFCM situation and anticipation of corrective measures);

– Daily Operations (real-time adjustment of traffic flows to available capacity);

– Events and Scenario Management (resolution of potential capacity/demand imbalances caused by seasonal or significant events, by applying ATFCM solutions);

– Network Operations Plan (NOP) Coordination (optimising ATM operations' overall performance through cooperative planning).

5. Enhanced traffic flow management system role and main principles of operation

The main systems of Network operations (NOP) are (Fig. 4):

– Enhancement Tactical Flow Management System (ETFMS) which lies at the core of ATFCM services;

– Integrated Initial Flight Plan Processing System (IFPS) which underpins Flight Planning services [Integrated…2011];

– Central Airspace and Capacity Database (CACD), formerly the ENV Database: it is the common airspace data repository feeding operational systems and enabling aeronautical data services.

These systems are complemented peripherally by more specialised systems such as:

– the Repetitive Flight Plan System (RPL);
– the Archive System (DWH or Datawarehouse);
– the IFPS Validation System (IFPUV);
– the Pre-Tactical System (PREDICT).

The Tactical (ETFMS) contains flight data for the following forty-eight hours. Initially, it is fed with RPL for that period and later with Flight Plan Messages in order to present the best picture of air traffic demand. This data is later updated by ATC information on the actual flight situation or any change to the initial flight plan (e.g. new route).

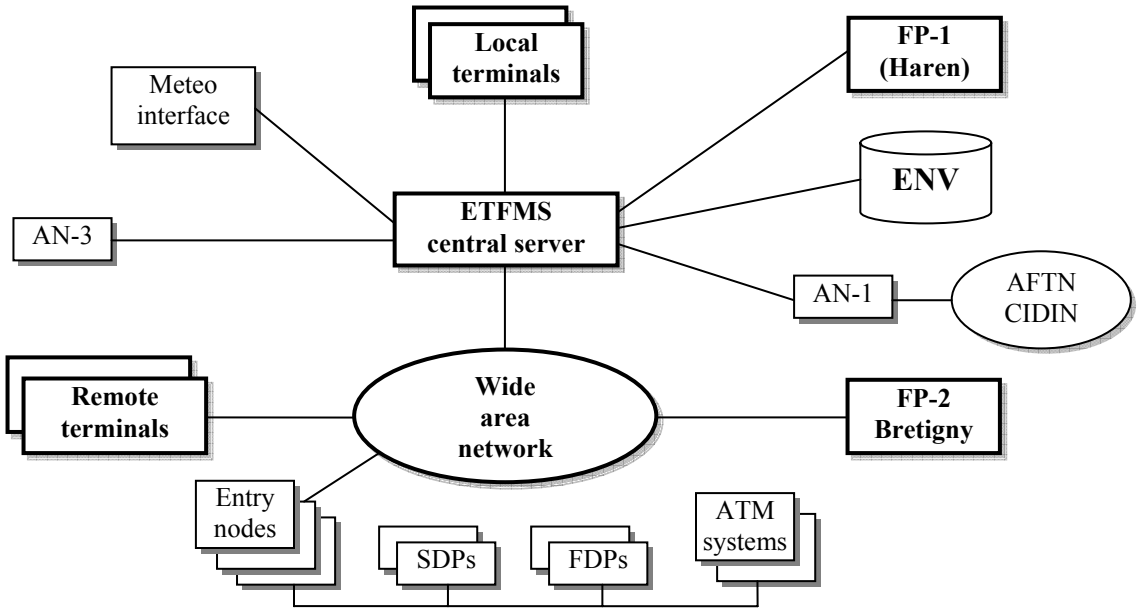

Fig. 4. Enhanced traffic flow management system overview

The tools for exploiting this data allow examination of the anticipated air traffic demand for the following day. Aircraft Operators (AOs) and Flow Management Positions (FMPs) can access the database via a terminal.

The main purpose of the ETFMS system is to compare traffic demand with the ATC (sector) capacity available.

In cases where demand exceeds the ATC sector capacity, the system makes the information available to the Flow Management Controllers in the NMOC and to their Flow Management Position (FMP) colleagues in the various ACCs.

Together they decide whether or not to implement a 'regulation', delaying flights through the allocation of a departure slot which moves the excess traffic out of the overload period. Re-routing information is also provided to the Aircraft Operators.

The ETFMS system has two main functions:

1. The calculation of the traffic demand in every sector of the NM Area of Operations, using the flight plan information received from the Aircraft Operators (AOs) via the Initial Flight Plan Processing System (IFPS).

2. The complex slot list calculation, allocation and distribution to the parties involved (ACCs, AOs etc). This part of the system is called CASA (Computer Assisted Slot Allocation).

The ETFMS System has the following sub-functions [Air…2011, Integrated…2011]:

- Environment Data Capture and Processing;
- Flight Data Capture;
- Profile Calculation;
- Load Calculation;
- Rerouting;
- Human Machine Interface;
- The Exchange of Messages;
- The Computer Assisted Slot Allocation (CASA) (Algorithm is located in the very heart of the interaction between the ETFMS system and ATC. Traffic volumes to come under CASA control are activated by the flow manager).

6. Air traffic flow and capacity management implementation in Ukraine

The ATFCM in Ukraine is provided by the CFMU with support of FMPs (flow management positions), located in each ACC (area control centre), and is used for:

- maximum use of available ACCs capacity;
- avoidance of ACCs overloading and concordance of demand traffic and available capacity of system;
- optimizing the traffic flows;
- provision of users with actual ATFCM information for efficient flight planning.

Interaction between FMP and CFMU is conducted according to appropriate agreements, concluded by ACC Chief and CFMU Director.

The FMP operation is carried out according to "Standardised FMP operations manual", approved by the UkSATSe General director. The "Standardised FMP operations manual" is a core sample to elaborate local FMP documentation.

The FMP workplaces are organized in accordance with the general requirements to air traffic flow management workplaces and approved by the UkSATSe General director.

7. Conclusions

ETFMS is an important step in the improvement of the ATFCM process by improving short-term traffic demand forecasts, reducing over-delivery and enabling more accurate slot allocations thus improved utilisation of the available capacity.

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В.П. Харченко[1], Ю.В. Чинченко[2]. Концепція управління потоками повітряного руху та пропускною спроможністю в Європейському регіоні
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Проаналізовано дослідження Євроконтролю щодо управління потоками повітряного руху та пропускною спроможністю. Розглянуто статистику повітряного руху, стадії управління потоками повітряного руху і пропускною спроможністю та розширену систему управління потоками повітряного руху. Наведено принципи впровадження концепції та вплив на систему управління потоками повітряного руху і пропускною спроможністю. Запропоновано загальні рекомендації, що можуть бути придатні до умов аеронавігаційної системи України.

Ключові слова: Європейська програма організації повітряного руху; організація повітряного руху; розширена система управління потоками повітряного руху; система первинної обробки планів польотів; статистика потоків повітряного руху; управління потоками повітряного руху та пропускною спроможністю; центральний орган управління потоками повітряного руху.

В.П. Харченко[1], Ю.В. Чинченко[2]. Концепция управления потоками воздушного движения и пропускной способностью в Европейском регионе
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Проанализированы исследования Евроконтроля относительно управления потоками воздушного движения и пропускной способностью. Рассмотрены статистика воздушного движения, стадии управления потоками воздушного движения и пропускной способностью и расширенная система управления потоками воздушного движения. Приведены принципы внедрения концепции и влияние на систему управления потоками воздушного движения и пропускной способностью. Предложены общие рекомендации, которые могут быть пригодны к условиям аэронавигационной системы Украины.

Ключевые слова: Европейская программа организации воздушного движения; организация воздушного движения; расширенная система управления потоками воздушного движения; система первичной обработки планов полетов; статистика потоков воздушного движения; управление потоками воздушного движения и пропускной способностью; центральный орган управления потоками воздушного движения.

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