

TOWARDS TO COLLABORATIVE AIR TRAFFIC AND AIRPORT MANAGEMENT

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Abstract

At this moment, it is not yet developed an effective intra-connecting data sharing between Air Traffic Management (ATM) providing and Ground Operations, essential for collaborative procedures planning, that impose losses in term of delay (time), fuel consumption, airlines operational cost and insufficient service quality of all parties in air transportation chain.

Procedure planning methodologies within ATM services and Airport system are unrecognisable, especially in real-time operational surrounding – in pre-tactical and tactical (decision making) phases. Besides operational disruptions and capacity shortage, consequence of actual unsynchronised planning impacts overall environment and safety performance. The research need is therefore strong technology-driven and orient to develop applied model of the Air Traffic and Airport's Collaborative Decision Making system (AA-CDM) with performance-based intra-connection. Such model encompasses the main functions of ATM regulation and Airport's air-side organisation, assumes a given and onward planned surrounding of European ATM services provisioning. The aim of required research can be summarised by the three high level objectives: - Determine the common criteria to make recognisable, comparable and intra-relating performance indicators of Air Traffic Management and Airport Management; - Identify subsystems of ATM and Airport-CDM, which substantial upgrading and improvement support increasing of capacity and efficiency of the whole air transport system; and - Develop the new model of AA-CDM, which should be capable and feasible for accommodation in operational and institutional framework both the Europe-wide and at the national level.

This paper presents research background and describes the complex of targeted researches need to be performed, with support of critical stakeholders, which would be mutually converged to common developing matrix of dynamic interactions respecting

changeable policy, technological and operational context.

Keywords

air transport, air traffic management, airport collaborative decision making

INTRODUCTION

European airspace is one of the most congested airspaces in the world with over 26.000 flights in the peak day with huge collateral effects of delaying and negative environmental impact. It is predicted that air traffic will increase twofold by 2020. Such development pathway ultimately imposes some subsidiary objectives, which are articulated by notion of safety and environment. For the purpose of European network coherence, as well as air traffic and network management based on safety and efficiency, concept of the Single European Sky has been initiated. Main objectives of the SES initiative are restructuring of European airspace, creating additional capacity and increasing the overall efficiency.

Safety and environmental issues on the one hand and capacity and efficiency on the other are often antagonistic. Sufficient safety and sustain environment are a necessary condition for further increase of capacity. A capacity shortage, which may prevent European ATM to serve air traffic increase of approximately 5 percent per year on average for the next decades, can be interpreted as a safety and environmental barrier.

There are several potential changes of the ATM system that will increase capacity and efficiency of the air transport system. Some of these changes concern the introduction of whole new concepts, such as collaborative decision-making, through market-demand, or Free Flight, partially driven by technological innovation, while other changes are

relatively simple improvements of procedures on a particular airport. Operationally improved Airspace Management can also enhance capacity and efficiency, for example by means of functional blocks of airspace or the flexible use of airspace among civil and military aviation.

The hypothetic research question is on which specific ways – supportive to the increase of capacity and efficiency - achieve more comprehensive approach of air traffic and airport management relationship, respecting subsidiary objectives of safety and environment.

The Single European Sky Initiative was launched in 2004 after severe air traffic delays in the late 1990s. The first Single European Sky (SES) package contained a framework regulation and three technical regulations on the provision of air navigation services, organization and use of the airspace and the interoperability of the European air traffic management network. SES I regulations were designed to enhance safety and to restructure the airspace according to traffic flows instead of along national borders. Even though SES I changed the situation, capacity was still a concern. In 2009 the European Union (EU) updated the SES legislation by second package. SES II package had four pillars – performance, single safety framework, new technologies and managing capacity on the ground. Great emphasis has been placed on the aviation environmental impact and the fuel crisis made airline focus on cost efficiency. Thus the introduction of Free Route Concept would bring significant benefits to all stakeholders flying in the European airspace.

Airport collaborative decision making is a joint initiative of EUROCONTROL, ACI Europe, Civil Air Navigation Services Organization (CANSO) and International Air Transport Association (IATA) which aims to improve the performance of aircraft operations in all segments of the air transport system. System seeks to reduce delay, increase predictability of operations and increase the capacity of entire system. The A-CDM concept involves implementation of a set operational rules and automated process defined by EUROCONTROL in document “Airport CDM Implementation Manual”. Munich airport represent the first airport in Europe which is fully implemented the Airport CDM system.

In 2007 a number of States, Air Navigation Service Providers (ANSPs) and Functional Airspace Blocks (FABs) proposed development towards implementation of Free Route Airspace. The common risk was the transition from fixed route network to offering direct routes, which are tailored to contribute to airspace performance improvements on capacity, efficiency and environment. The Free Route Implementation has started on the outer borders of the European Union, such as Portugal, Ireland, Danish-Swedish

Functional Airspace Block, Maastricht Upper Area Centre, and Karlsruhe Upper Area Centre.

Although this represents new technology and information culture, the benefits of A-CDM have been recognized by several airports in Europe, which made full or partial progress implementation. These airports are: Brussels Airport, Paris CDG Airport, Zurich Airport, Dusseldorf Airport, Frankfurt Airport, Munich Airport, Helsinki Airport, Vienna Airport (in progress, and Budapest Airport (in progress).

DEVELOPMENTS IN ATM

Historically, ATM service provisioning was considered a government task, to be executed by civil servants organized under the same authority as ATM rule-making, airports and airworthiness certification, and flight crew licensing. Currently, it is considered more appropriate to execute ATM service provisioning by an organization that has some managerial autonomy from the government authority. The Single European Sky EC regulations further state that a National Supervisory Authority shall be established independently of Air Navigation Services providers. In several countries, the clear separation between operational and regulatory function is not yet realized, while in other countries this separation is well implemented, for example after corporatization or even privatization of some of the ATM service providers.

The nature of ATM service provision is also subject to development, as a result of technological innovation, the increase of air traffic demand, the pressure from airspace users for higher efficiency and society pressure on environmental issues. Two of the main objectives of the Single European Sky initiative concern the optimization of capacity meeting the requirements of all airspace users and the minimization of delays. This and the further innovation of techniques as positioning, data processing and digital communication make the ground and airborne domains more and more integrated. The words of EUROCONTROL ATM Strategy for the years 2000 and beyond read as follows: Best use of airspace can only be achieved if the traditional Air Traffic Control concept is replaced [...] by a new ATM concept [...] encompassing the gate-to-gate concept, the consistent management of all phases of flight, the application of uniform principles, the integration of airport airside operations into ATM and system-wide information-sharing... [1]

Enabled by the Single European Sky legislation, the SESAR programme intends to design and implement a single European ATM Master Plan, taking into account technological, operational, and institutional aspects. The diversity of the partners aims at facilitating enlarged harmonization,

interoperability and cooperation comprising industry, Airlines, Airports and ANSPs. The renewed commitment, also stemming from bodies such as the EC, EUROCONTROL, CANSO and IATA, should decrease the fragmentation in ATM technology and procedures.

Second package of SES initiative introduced the measurement of the ATM performance. Measurement in ATM performance is driven by four key performance targets: safety, cost-efficiency, capacity and environment. The aim of the ATM performance measurement is to require air traffic control organizations to change and provide better services at lower cost. All Member States of the EU are obliged to draw and elaborate Performance Schemes for ATM, that contain targets for each identified key performance area (KPA) for defined reference period. European Commission statement clearly assigned the problem of Performance Scheme implementation: In recent years, the delivery on performance targets has fallen significantly short of the overall level of ambition. This is because, under the current system, Member States have the ultimate say on targets and the adoption of corrective measures in case targets are not reached. [2]

Flight efficiency consists of a horizontal (flight distance) and vertical component (difference in the altitude of flight). Horizontal component performance indicators of flight efficiency relate to the difference between the actual distance of flight and great circle distance, assuming that each flight is the only aircraft in the system, and that it is not subject of any restrictions.

Flight efficiency always involves trade-offs – safety versus capacity, fuel cost versus time cost, ground versus airborne delay, noise versus emissions, etc. A reduction of few miles in flight length by using more direct routes can result in significant savings on a yearly level. [3]

The biggest cause of inefficiency in both the lateral and fuel analyses was observed to be standard routes as well as the arrival holding, vectoring and congested airspace.

Limited airport capacity causing arrival delay is the root cause of this issue. Planned increases in airport capacity are unlikely to keep pace with growth in aircraft movements, and hence it will become increasingly important for ATM to manage arrival delay in a more environmentally-friendly way. Future concepts that involve four-dimensional trajectory management should greatly reduce the need for holding and vectoring within the destination terminal area. [4]

The overall European ATM system, which is composed of many different national ATM systems, provides limited flexibility when it comes to rerouting flights dynamically to avoid congested sectors on any given day. Thus, in developing ground-holding strategies and planning air traffic

flows, European ATFM must consider a true network of capacitated elements – en route sectors and airports. [5]

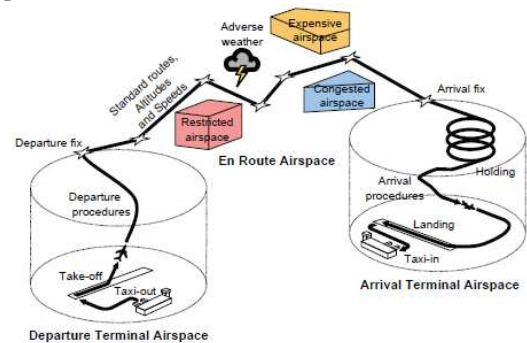


Figure 1. Potential causes of flight inefficiency

Source: Reynolds, T., 2009.

The implementation of the Free Route Concept (FRA) is seen as one of the concepts that could improve the overall efficiency of ATM in Europe, in which the fixed route network is removed from part of the upper airspace. FRA is defined as a specific airspace within which users shall freely plan their routes between an entry point and an exit point without reference to the ATS route network. In this airspace, flights will remain subject to air traffic control. [6]

According to EUROCONTROL, Free Route Airspace refers to a specific portion of airspace within which aircraft operators may plan a route freely between a defined entry point and a defined exit point, with the possibility of deviating via intermediate navigation points without reference to the fixed route network. Within this airspace, flights remain at all times subject to air traffic control and to any overriding airspace restrictions. Free Route Airspace aims to assure the implementation of shorter routes and more efficient use of the airspace across the Europe. A FRA concept allow to set up a direct route network for 24/7 operations, saving aircraft operators several million kilometers in terms of flight distance.

DEVELOPMENTS IN A-CDM

Due to future traffic growth and scarce airport infrastructure, airport delays will become more acute. Airport capacity is currently the most restricting bottleneck in the overall European air traffic management system. [7]

The implementation of Airport Collaborative Decision Making (A-CDM) as a system or Culture from the industry point of view is a new and technologically advanced concept in aviation. This is the first and only initiative, which directly gathers all stakeholders trying to achieve collaborative results, such as increased efficiency, punctuality, safety and environmental suitability.

Airport Collaborative Decision Making is a concept that has been designed by EUROCONTROL and represents one of the five measures in the Flight Efficiency Plan published by IATA, CANSO and EUROCONTROL.

A-CDM is predicted as an innovative concept of proactive decision-making in air traffic system, which aims to replace the current centralized system of air traffic management with collaborative decision making in respect to airport's airside operations. To establish such system it is necessary to involve all stakeholders in the air transport system and provide timely information to all users. The main stakeholders in this system are ATC, Airports and Airlines.

In actual ATM provisioning concept, when traffic demand exceeds the available capacity at an airport or en-route control centre, aircraft are held at the departure airport and subjected to ATFM slots, thereby causing overall delay. [8]

The implementation of Airport-CDM implies:

- a change in procedures, and
- a cultural change within all involved stakeholders.

The system is based on two primarily key elements:

- the predictability of events – which would result in optimization of each process related to aircraft and airport operations, and
- performance of on-time operations – which would influence increase of airport and ATC capacity from one side and more directly airlines efficiency and aircraft utilization from another side.

The steps to be made for organizing collaboration between airports and the ATM network in achieving A-CDM are the following: [9]

- connect airports to the network (tactical electronic information exchange) – it should be a two-way communication based on data exchange and thrust (not one-way),
- connect airport operational plan (AOP) and network operational plan (NOP) - (pre-tactical, tactical and strategic electronic information exchange).



Figure 2. Stakeholders involved in Airport CDM

The Airport CDM concept consists of seven core elements:

- Airport CDM Information Sharing,
- CDM Turn-round Process – Milestones Approach,
- Variable Taxi Time Calculation,
- Collaborative Management of Flight Updates,
- Collaborative Pre-departure Sequence,
- CDM in Adverse Conditions,
- Advanced Concept Elements.

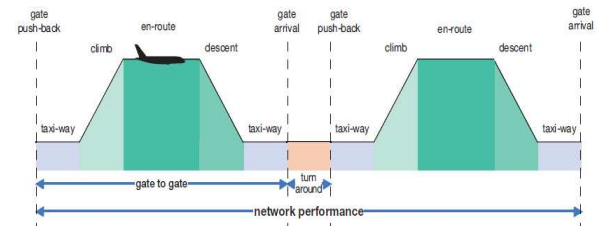


Figure 3. Integrated ground and airborne sectors

Source: Schmitter, A., Laveyne, L., 2013.

The objective of the Airport CDM implementation is to improve the overall efficiency of operations at an airport, with a particular focus on the aircraft turn-around procedures which would be achieved through the enhancement of decision making process by sharing of relevant up-to-date information.

Taking into account all available resources and requirements of those involved, the main output of CDM will be more accurate Target Take-Off Time, relevant for improving ground but also en route planning. [10]

RESEARCH FRAMEWORK

According to the specific sectoral frames of ATM and CDM, developing of collaborative air traffic and airport management model assumes intra-connecting of the main function of ATM providing and airport operations in a given and onward planned surrounding of European ATM services provisioning, as well as respecting changeable policy-driven, technological and operational availability context.

Such model developing can be summarised by the following three high level objectives:

1. Determine compatible criteria to make recognisable, comparable and intra-relating performance indicators of Air Traffic Management and Airport Management.
2. Identify subsystems of ATM and A-CDM, which substantial upgrading and improvement support increasing of capacity and efficiency of the whole air transport system.
3. Develop the new and improved model of AA-CDM.

Referring to first high level objective, the common criteria have to be identified for assess capacity and efficiency related performances of ATM and Airport systems, which will be basis for indicators classification and designation those which are mutually conditioned.

Some of current system weaknesses as suggested in the second high level objective have already been identified, such as the incomplete coverage by current regulations and the insufficient parameterisation and setting of quantifiable and measurable performance indicators, which actually are not comparable and complementary in relation ATM-Airport, which are on some points inconsistent and on other points not enough or even not at all defined for usage in real time operations.

In addition, ANSP Performance Scheme, which is actually in initial phase of implementation, revealed an improving but still rather slow and very inconsistent degree of performance-based plan implementation. The causes are the lack of expertise in several national regulatory/supervisory authorities, the limited availability of human and financial resources within service providers and supervisory bodies, a pronounced lack of political awareness, and even a lack of political will. There are particular worries about the implementation of safety related targets, which have triggered other key performance area actions.

The third high level objective is to develop the appropriate Air Traffic and Airport – Collaborative Decision Making (2A-CDM) model, which will assure intra-connecting procedures planning, capable of applying in real time operations.

The collateral aim of the research refers to high level objectives is to investigate some gaps between safety regulations, certifications and standardisations, possible underlying factors and causes rooted in the history of European aviation safety regulation. It does not only intend to identify and analyse several issues, but also intends to link them and to draw applied synthesis.

Only as an example, the European Strategic Safety Action Plan links an imperfection, namely the slow implementation of ESARRs with an expected organisational change, namely the extension of EASA's competence by notion "... the perceived differences between ESARRs and transposed EU legislation, causing some to adopt a "wait and see" approach to updating national legislation. Some States fear that the technical capability of the EC and EASA in establishing regulations is inadequate and will not deliver adequate support for implementing the technical harmonisation and improvement programmes now being managed by EUROCONTROL" [11].

There are other opinions stating that the slow safety requirements implementation can better be explained by the quality of the regulatory material, the lack of expertise in several national regulatory authorities and the imbalance between self-regulation and descriptive standards.

With regards to safety matter some of the imperfections in current European ATM regulations and supervisory functions are due to the intrinsic, almost unavoidable difficulties of ATM safety. ATM services are provided in a highly technological surrounding under economic pressure with complex and dynamic interactions between several parties, where responsibilities are distributed and where particular safety occurrences can impact the whole network and cause disruption of the whole air transport system.

Notwithstanding this, it might be required to change the current way of safety regulation fundamentally, whether in an evolutionary or in a revolutionary way. This would require that organisations as ICAO, EASA/EUROCONTROL-SRC and national CAAs change their way of thinking, that the responsibilities and tasks are redistributed and that new tasks are added.

It might turn out that the current logic of safety regulation and supervision needs some adaptations, not just to enable maintain or increase of air traffic safety itself, then also allow efficiency increase in other key performance area, namely environment, capacity and cost-efficiency.

With respect to subsidiary objectives the implementation of Free Route Concept in Functional Airspace Block Central Europe (FAB CE) assumes the significant benefits in term of ATM performance measurement, as follows – lower fuel carriage, less engine running time, better network and flight predictability, better flight efficiency, greater cost-effectiveness, reduced environmental impact, and better air traffic management performance through more accurate traffic prediction and improved sector workload.

The implementation of A-CDM at Zagreb Airport, applicative for other airports, assumes environmental benefits as following:

- sequence start up based on readiness time, navigation congestion status (slots) – benefit in spending less fuel avoiding waiting for take-off in line and holding in arrival,
- less fuel spending on take-off waiting results in reduces CO2 emissions and airlines' fuel costs,
- shortening duration time of engine noise at thresholds due to very often roll take-off.

The implementation of A-CDM is in direct line with other environmental friendly procedures as CDO (Continuous Descent Operations) and CCO (Continuous Climb Operations).

CONCLUSIONS

The introduction of FRA concept of operation in FAB CE airspace would bring significant benefits to the airspace users, in terms of flight efficiency, reduction of flight time, flying distance, fuel consumption and CO₂ emission. Also it is expected that due usage of the automation tools in the ATM, the FRA concept would significantly impact the overall efficiency and performance of ATM services, respective to the greater operational flexibility and capacity enhancements.

Due the implementation of A-CDM procedures, each stakeholder would have benefits in the way of optimization and better utilization of the current capacity. Airports would be served with all the necessary information at the right time for demand oriented organisation of ground handling; ATC would be able to respond with appropriate airspace sectorisation and accurate defining a sequence for each aircraft in landing and take-off phases; Airlines would have flexible possibility to optimise all network and decrease delay time.

The direct impact of the implementation of the new ATM concept such as FRA concept would be better utilisation of airspace provided in terms of improved flight efficiency for airspace users, thus implying the reduction of fuel cost e.g. lower fuel consumption. The second benefit would be in the environmental part as the direct routing reduces the flight time and flight distance, thus lowering the emission of CO₂ in the airspace. Currently all the traffic in the FAB CE airspace is aligned on the currently developed route network that is based on the current air traffic demand, historical legacy (navigation equipment), and letters of agreement between service providers. The introduction of FRA concept in the FAB Central Europe would bring significant improvements in the performance of the service providers and as a consequence have significant impact on the business of the airspace users.

The direct impact of the implementation of A-CDM would be in better utilisation of equipment, punctuality of all airport operations and increasing current infrastructure capacity. With that positive impact on airport traffic, it would influence secondary benefits in the environmental issue. Currently, all aircraft accept permission for starting the engine without any collaboration or information sharing with other stakeholders or destination airport, in term if this airport is capable for accept aircraft which plan fly to this location. This "no share information" resulted with more fuel burned during holding, greater CO₂ emissions, increased noise, overcapacity in handling segments. Through A-CDM implementation all of the mentioned problems would be solved and improved.

The predicted developing of performance-based air traffic and airport's collaborative decision

making system of service procedures planning and integration of onboard and ground operation domains within first stage through 2A-CDM model would have significant impact to capacity and efficiency of air and airport's traffic system, which would be subject of further enhancing in long-term concept of 3A-CDM, which assumes their data-share networking with Airline's procedure planning domain.

ACKNOWLEDGMENTS

This paper is prepared as extracted overview of project proposal titled Collaborative Air Traffic and Airport Management (CATAM) for Research Grants 2013 tender by Croatian Science Foundation. CATAM research group encompasses professors, post-doc and doctoral students employed at Department of Air Transport, Faculty of Transport and Traffic Sciences, University of Zagreb, Airport Zagreb, Airport Split, and Eurocontrol.

REFERENCES

1. EUROCONTROL Air Traffic Management Strategy for the years 2000+, Volume 1, Edition 2003.
2. European Commission Single Sky: Commission acts to unblock congestion in Europe's airspace, 2013.
3. Hustache J.C., Kettunen T., Fuller I., Knorr D., „Flight Efficiency Studies in Europe and the United States“, USA/Europe ATM Research and Development Seminar, Baltimore, 2005.
4. Reynolds T., "Development of Flight Inefficiency Metrics for Environmental Performance Assessment of ATM", USA/Europe Air Traffic Management Research and Development Seminars, Napa, 2009.
5. Lulli G., Odoni A., „The European Air Traffic Flow Management Problem“, Transportation Science, Vol. 41, No. 4, (2007), pp. 431-443.
6. EUROCONTROL Free route airspace concept, Review document for AMWG/12, Draft issue, 2001.
7. Katsaros A., Psaraki-Kalouptsidi V., „Impact of Collaborative Decision-making Mechanisms on Operational Efficiency of Congested Airports“, Airport Management, Vol. 5, No. 4, (2011), pp. 351-367.
8. Ranieri A., Castelli L., „A Market Mechanism to Assign Air Traffic Flow Management Slots“, USA/Europe ATM Research and Development Seminar, Napa, 2009.
9. Schmitter, A., Laveyne, L., „What is SES Legislation? How is SES going to affect

- operations at and around airports?“, Sesar Roadshow, 2013.
10. Goni Modrego E., Iagaru M.G., Dalichampt M., Lane R., „Airport CDM Network Impact Assessment“, USA/Europe ATM Research and Development Seminar, Napa, 2009.
 11. European Strategic Safety Action Plan Implementation Programme – Monitoring the Safety of Europe’s sky, EUROCONTROL, 2005