Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 134 (2016) 237 – 244

Procedia Engineering

www.elsevier.com/locate/procedia

9th International Scientific Conference Transbaltica 2015

Air Traffic Smoothness as a Universal Measure for Air Traffic Quality Assessment

Piotr Andrzej Dmochowski[a]*, Jacek Skorupski[b]

[a]*Polish Air Navigation Services Agency, Wieżowa 8, 02-147 Warszawa, Poland*
[b]*Warsaw University of Technology, Koszykowa 75, 00-662 Warszawa, Poland*

Abstract

Air traffic in European airspace is coordinated centrally by the air traffic flow management services – Network Management Operation Centre (NMOC). Their main task is to compare resources (number and capacity of air traffic control sectors) and needs (size of the planned and actual traffic). If it is found that the planned traffic exceeds the capacity of available airspace, corrective actions should be carried out. They consist in changing the takeoff time, or changing aircraft routes so as to avoid congested sectors or even cancelling the flight. Unfortunately, determining only the traffic volume is not sufficient to identify the needs, because very important are also: aircraft trajectories, manoeuvres performed, types of aircraft, their speed and other restrictions. Indeed, these factors determine the possibility to control the traffic by air traffic controllers. This makes it necessary to seek another indicator characterizing the traffic that must be handled. The paper proposes to use the notion of air traffic smoothness as a new, universal measure for characterizing the quality of air traffic. It can also serve as a measure of the traffic volume in the control sector or even as a traffic safety measure. The concept of smoothness is easier to use than the notion of the traffic complexity, which is increasingly being used, e.g. in the assessment of the capacity of the sector. The paper presents a new method for determining the air traffic smoothness, which uses both flight plans, their current implementation and the so-called favourable flight plans. On the basis of the measured data it is shown how to calculate the traffic smoothness for selected sectors. Indicating directions of further planned research, calculations were made to determine the relationship between the air traffic smoothness and its volume, which in turn may allow the use of the concept of smoothness to determine the capacity of control sectors and supporting air traffic flow management services.

Peer-review under responsibility of the organizing committee of Transbaltica 2015

Keywords: air traffic control; traffic safety; traffic complexity modelling.

* Corresponding author
E-mail address: p_a_dmochowski@o2.pl

Peer-review under responsibility of the organizing committee of Transbaltica 2015
doi:10.1016/j.proeng.2016.01.065

1. Introduction

Air traffic flow management in European airspace works in a centrally coordinated way. Flight parameters defining a four-dimensional trajectory of aircraft are reported before flight to Network Management Operation Centre (NMOC) in Brussels in the form of a formalized sheet of a flight plan. NMOC deals with initial coordination of air traffic flow. It aims to minimize the number and the time of aircraft delays and at the same time to increase the airspace capacity. Simultaneously, NMOC services strain to increase the safety of air traffic and the effectiveness of air traffic flow. In the case when:

- the submitted flight plan does not collide with other plans,
- flight does not go through the sectors in which the air traffic volume is close to their capacity,
- the weather conditions are good,

then a flight is carried out according to its planned trajectory. But when at least one of these conditions is not fulfilled, then a submitted flight plan is modified. It is NMOC's task in cooperation with Air Operators (AO) and Flow Management Position services (FMP) which deal with the air traffic flow in the airspace through which a passage is planned. Generally, the possible modifications are: to delay the takeoff (so-called slot allocation) or to change the route in order to bypass the airspace sectors which generate restrictions (so-called re-routing). In critical cases a flight can even be cancelled.

2. Air traffic and measures of its assessment

Nowadays, one of the key parameters which enables a proper organization of the traffic itself and the work of ground services – is the traffic volume in the air traffic control sector. This term is not unequivocal. It can be understood as a flight intensity i.e. the number of aircraft coming into the sector in one unit of time (Eurocontrol 2013b). The essence of this approach is to show the total number of aircraft under control. It can be also defined as traffic density which means the number of aircraft in the sector weighted by the time spent in the sector in one unit of time (Skorupski 2008). Selecting one of these approaches depends on the purpose of the research.

2.1. Air traffic control (ATC) sector capacity

The term of the sector capacity is an example of a very important value describing the ability to handle aircraft in the sector in the context of air traffic volume. General definition of the sector capacity defines it as the maximum number of aircraft which can be safely handled in one unit of time according to international rules. In the case of ATC area sector which is the topic of this paper, the time of a controller occupancy in one unit of time is a numerical parameter which is the measure of the sector capacity. It depends highly on the traffic volume. It is obvious that heavy traffic needs more time to be served by a controller. An excessive increase of traffic volume can lead to the failure of safety measures. Thus some barriers are imposed on the traffic volume. The barrier corresponds to a maximum controller occupancy time. It is supposed that at this limit traffic volume the controller occupancy time does not exceed 70% of an hour, which is considered as a safe value (Majumdar et al. 2005).

Thus, in the case of ATC area sector a factual limitation is the air traffic safety, expressed by a controller's ability to handle a certain number of aircraft. Stating in a more or less arbitrary way, the limit value of a controller's occupancy time, one obtains the corresponding limit value of traffic volume.

2.2. The quality of air traffic

With reference to airports, an important parameter which depends on the traffic volume is the average delay for a single air operation. Similarly to ATC area sector capacity an increase of traffic causes an increase of the average delay. Thus, we can determine a barrier for an increase of traffic volume for which we state that an average delay does not exceed a permitted value (Dmochowski, Malarski 2004; Skorupski 2004). The similar approach is used, for example, when stating the capacity of a passengers' check-in system.