Conflict resolution of North Atlantic air traffic with speed regulation

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Abstract

Since air traffic volume increased over the oceanic airspaces, it has been primordial to improve oceanic air traffic management procedures. One of the most important limitations in the oceans air traffic is the lack of radar coverage. The availability of new surveillance means, called automated dependence surveillance broadcast system (ADS-B), permits to enhance the strategic flight planning over the oceans by reducing the separation standards. Besides, oceanic flights are mainly subjected to strong winds caused by the jet streams. In this work, we focus on optimizing the strategic flight planning over the North Atlantic airspace. First, we organize the traffic inside a route structure that benefits from both the Jet streams and the exploitation of ADS-B systems. Indeed, from one side, these routes are merged inside the jet streams in order to be as close as possible from wind-optimal routes. On the other side, these routes are constructed to fit in with the new separation standards required when implementing the ADS-B systems. Then, we resolve conflicts between aircraft via an optimization model based on a speed regulation. Simulations were conducted for a real traffic data. Computational findings show that the proposed methodology provides satisfying results.

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1. Introduction

In the last few years, there has been a growing interest at improving the efficiency of oceanic air traffic situation. In fact, due to their long duration, oceanic flights consume 26 percent of the total fuel consumption in the world. Besides, these flights yield 49 percent of the International cargo revenue and 20 percent of the passenger revenue [4]. In particular, the North Atlantic airspace (NAT) is considered to be the most congested oceanic airspace since it connects two densely-populated area namely Europe and North America. The NAT airspace presents several particularities.

First, the density of traffic over the NAT is steadily increasing. In fact, the International Air Transport Association (IATA) statistics estimates that the traffic growth over the NAT airspace was about 4.8% more in 2015 in comparison with 2014.

Furthermore, due to passenger demand and time zone differences, the NAT air traffic is divided into two flows: westbound flow, travelling from Europe to North America in the morning and eastbound flow travelling on the opposite direction in the evening. Due to these flows, most of the NAT traffic is concentrated uni-directionally, with peak westbound traffic between 1130 Coordinated Universal Time (UTC) and 1900 UTC and peak eastbound traffic between 0100 UTC and 0800 UTC.

In addition, flights operating in the NAT airspace are subject to very strong winds caused by the Jet Streams. These streams are fast air currents running mainly in west direction. Thus, eastbound flights exploit the jet streams to benefit from tailwinds, however, westbound flights prefer to avoid the jet streams and stay away from headwinds.

Finally, most part of the NAT airspace suffers from lack of surveillance tools. In fact, as the traditional radar relies up on ground-based sites, flights are unable to be tracked using these means of surveillance.

Regarding these issues, it has been primordial to find safe, robust and efficient procedures to organize this dense traffic. The present study focuses on establishing the required separation between the scheduled flights in the NAT at strategic level. In this paper, we refer to our earlier work presented in [2], however, the focus is different. In fact, in our previous work, we present a new route structure model for the NAT. Nevertheless, in the present work, we develop an approach for conflict resolution, inside the pre-defined route structure, based on a speed regulation.

The remainder of the paper is divided into four sections. The first section gives an overview of the theoretical background related to our research topic. The second section presents the problem formulation. We mainly outline the given data and we describe briefly the new route structure. The proposed conflict detection and resolution methodology is presented in Section IV. Section V summarizes and analysis the experimental results of this work. Some conclusions are drawn in the final section.

2. Background

The present section gives a theoretical background related to air traffic management over the NAT. We start by exposing the OTS routes, which represent the actual route structure in the NAT. Then, we introduce the functionalities of the ADS-B system and the benefits behind its deployment.
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