The follow-up on the Free Route Airspace Implementation in Slovakia with the proposed optimization model

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The follow-up on the Free Route Airspace Implementation in Slovakia with the proposed optimization model

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Abstract

This contribution is a free continuation of work FRABRA - Free Route Slovakia. The base of the concept FRABRA is the transition from current Air Traffic Services (ATS) Routes Network to Free Routes Operations in Slovak airspace. The main aim of this work is to define the content, inputs, and resources of the future work for FRA implementation in Slovakia with the proposed optimization model. The work also provides a general guide for researchers to apply current technologies, as Kopernio to search for appropriate resources related to their area of research.

Keywords

Free Route Airspace in Slovakia, optimization model, resources of Kopernio.

I. INTRODUCTION

Following the work concerning „*The implementation of Free Route Airspace (FRA) in Slovakia"[7],* this paper will provide the follow-up of the mentioned topic.

The paper is a part of the future work which will deal with the optimization model of the airway for commercial aircraft while ensuring all safety requirements. The main goal of the future work is to establish the optimization model that will support the further progress of FRA in terms of reducing delays, determination of the most appropriate FL etc. As the safety in aviation is on the 1st place and needs to be ensured in each step, the paper covers the European Commission and EUROCONTROL involvement into the topic. This is serving as a baseline for the implementation process, meeting the safety procedures etc. for such a concept.

Since writing the last work *[1],* the situation of FRA in Slovakia has moved forward, therefore, the progress up to date is provided in *Chapter III*. The description of the updated situation is based on the latest information provided by LPS SR, š.p. *[5]*.

Having defined the main goal of the future work, *Chapter IV* is describing the route optimization and what needs to be taken into account.

As the authors find very important to use relevant sources for the research, the last chapter *(Chapter V)* has been created as a supporting guideline for the young researchers and Ph.D. students in order to guide them in looking for the relevant sources related to their area of a research.

II. EUROPEAN COMMISSION AND EUROCONTROL INVOLVEMENT

EUROCONTROL is responsible for the implementation of an advanced concept of operations, including free route operations, and a pan-European view of FRA deployment. However, the general framework of the Single European Sky needs to be completed by more specific and detailed implementing rules. Therefore, further development of FRA has been made by the approval of Commission Regulation (EU) No 677/2011 by stating detailed rules for the implementation of air traffic management (ATM) network functions and amending Regulation (EU) No 691/2010. In Annex I of this Regulation, the European Route Network Design function and the European Route Network Improvement Plan (ERNIP) is included.

As a part of the ERNIP, the Network Manager is developing and maintaining the following, *[2]:*

- **The European Route Network Improvement Plan (ERNIP) Part 1 - A European airspace design methodology** – General principles, guidelines and technical specifications for airspace design: includes a Free Route Airspace Concept;
- **The European Route Network Improvement Plan (ERNIP) Part 2 - European ATS route network (ARN) versions**: includes all the free route airspace projects scheduled for

development and implementation over a five-year rolling period;

- **The European Route Network Improvement Plan (ERNIP) Part 3 - ASM Handbook**: includes all the necessary civil/military aspects related to free route airspace;
- **The European Route Network Improvement Plan (ERNIP) Part 4 - Route availability document (RAD) user manual**: includes an appropriate route orientation and flight plan facilitating measures for free route airspace.

III. FREE ROUTE AIRSPACE SLOVAKIA – PROGRESS UP TO DATE

In spring 2017, ACC Bratislava has been invited to join Hungary, Romania, and Bulgaria (SEEN FRA) during the night operations. Slovakia accepted the invitation and decided to join night cross-border FRA operations. The following list of the actions is presenting the planned steps (with the timeline) already agreed between EUROCONTROL and LPS SR, š.p. *[5]*.

- Until the 5th of December 2018, Slovak airspace will be operated by DCT 24H.

- 6th of December 2018 – 27th of March 2019, DCT in Slovakia will be used only during day operations (05:00-23:00/04:00-22:00). Night operations will be different; Slovakia will join SEEN FRA operations. SEEN FRA cross-border FRA operations allow the flights to fly across the airspace consisting of 2 or more states without referring to the national or operational boundaries. Especially, for this case, it will be possible to enter the SEEN FRA in Bulgaria using FRA Entry Point and to leave the same airspace in Slovakia using FRA Exit Point. The background information concerning the planned expansion is included in the AIC A 3/18 *([6])*.

Figure 1. The planned step for the period: 06DEC18 - 27MAR19

- Following the AIRAC cycle, 28th of March 2019, DCTs will not be used anymore. Instead of DCTs, in the area of responsibility of Bratislava ACC, the FRA with intermediate points will be implemented from FL 245 and above.

The airspace below FL245 will be operated by ATS routes.

The expanded SEEN FRA airspace will bring the optimization of the flight operations in a large volume of airspace. In addition, this expansion will bring operational, environmental and cost benefits, *[6]*.

Note: The detailed analysis of the benefits will be a part of the future work.

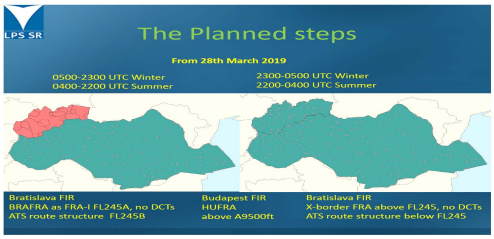

Figure 2. The planned step for the period: 28MAR19 onwards

IV. THE PROPOSAL FOR THE FUTURE MODEL IN ROUTE OPTIMIZATION

Route optimization is the process which can help to determine the most cost-effective route. It is not only about finding the shortest path in the complex network between two points moreover, it needs to include all relevant factors. The nodes usually present the network – each node presents a location and a route is a path through a set of nodes. Most real routing problems involve finding effective routes for vehicles, i.e. cars, trains, airplanes etc. The authors will take into account only vehicle routing problems related to airplanes.

There are 2 types of routing problems depending on the main goal whether it is referring to visit nodes (locations) or the arcs (the edges connecting the locations), *[4]:*

- node-routing problems

- arc-routing problems

The authors main goal is to find the optimal set of routes for a fleet of vehicles, i.e. planes delivering goods or providing services to various locations.

One of the possibilities the authors could do is to look for a set of routes with the least total distance, with no additional constraints on the vehicles. However, in aviation, the process is more complex. Therefore, more factors need to be taken into the account, in particular, the constraints in capacity, precedence relations, constraints with time, resource constraints.

Referring to the capacity constraints, the total demand of the locations on a vehicle's route cannot exceed its capacity. Locations can be airports, sectors, controlled areas etc. which have some limits in terms of the number of flights. As for the precedence relations, here the authors have to take into account the sequence of the locations which have to be visited, e.g. connecting flights. It means that the first location cannot be visited before second. Time constraints are very important in aviation, as each flight has assigned its own slot for departing and arriving. Constraints with resources will also be a part of the further analysis. Due to various strikes, e.g. ATC strikes, Cabin Crew strikes etc. the air traffic is highly affected – the results are huge delays of flights, cancelled flights and of course, unsatisfied passengers what cause additional costs for the airlines as they have to compensate these deviations from flight schedule.

V. SELECTION OF THE RELEVANT SOURCES

Nowadays, there is an enormous amount of the possibilities to obtain the sources for our further research. However, the most important is to distinguish those sources according to their relevance. For this purpose, the authors of this paper are using the technology named Kopernio.

This Chapter is dealing with the description of the mentioned technology along with its importance and usage.

Kopernio is a FireFox browser plugin. It enables one-click access to the scientific articles in the Web of Science. One of the requirements is that the fees for using Web of Science have to be paid in the network the user is working in, e.g. University network.

A. The installation of the Kopernio on the Technical University of Kosice, Slovakia [3]

The main steps how the system has to be installed and consequently how it works are provided below with the picture demonstration for easier imagination (in *Figure 3* below).

1) The installation of Kopernio plugin into FireFox:

- The plugin has to be installed in the PC and consequently accessed by clicking on it.
- After the step 1, the active window will appear where, the author writes the keyword concerning the research topic, e.g. “Airline optimization”, see *Figure 3*.

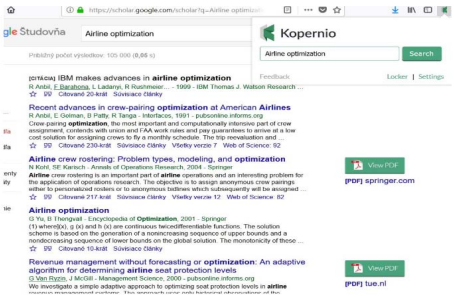

Figure 3. Kopernio System

- Kopernio will list the related articles in the different databases (Scopus, WOS, etc.) according to the relevance. The author is authorized to download the preferred article in .pdf format which will contain the source as well.

Some articles downloaded from the list and saved in Kopernio can be found in the directory that is visible in *Figure 4.*

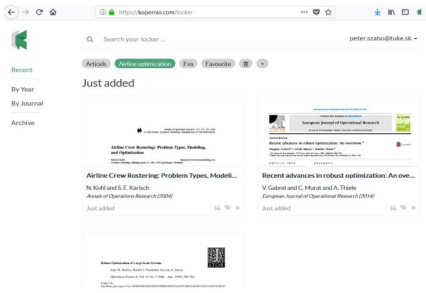

Figure 4. The downloaded articles in Kopernio

Kopernio also allows easier cooperation between authors in a way that authors working together on some article/paper/work can store common sources (and their references in the .bib format) into a secure Cloud – DropBox.

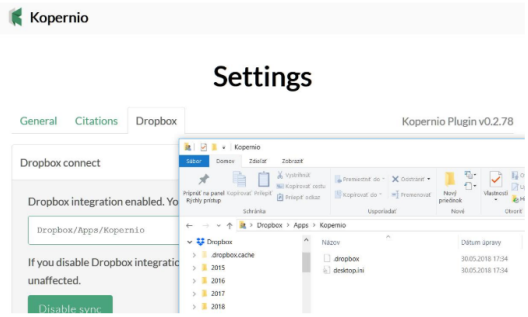

Figure 5. Kopernio and DropBox

In this case, beside the plugin Kopernio there is necessary to have a DropBox as well and to make a configuration between Kopernio and DropBox (picture demonstration of

the configuration between Kopernio and DropBox is visible in *Figure 5* and *Figure 6*).

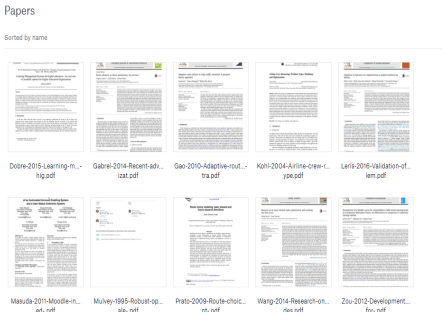

Figure 6. Display of the papers on DropBox

2) TUKE Virtual Private Network (VPN) connection to TUKE server

TUKE Virtual Private Network (VPN) connection to TUKE server has to be created. The steps are as follows:

- The installation of the application **Check Point Capsule VPN**;
- The Setting of VPN in Windows 10: Network connection – VPN – add VPN connection – enter the server name „**remote.tuke.sk**“ and the name of the connection „**TUKE VPN**“;
- To activate the network TUKE VPN (by entering login and the password);

After activating (all these steps), the TUKE network IP address will be associated to the user´s PC which will allow the user to use the services of Web of Science and other services of TUKE network.
In case of different Universities, there is necessary to find out the VPN University server and to enter their addresses instead of „remote.tuke.sk".

Important note:

- The activation of the TUKE VPN has to be done before the application Kopernio.

VI. CONCLUSION

The paper has been made as a part of the future work that will deal mostly with ensuring the safety requirements and optimization of the air route for commercial aircraft. Therefore, at the beginning of the work, the authors provided the list of the documents related to the topic along with the Commission Regulations (EU). The paper also provided the update of the Slovak situation in terms of FRA as since writing the last work *[7]*, the situation has been slightly updated. The detailed summary of the FRA on-going projects that are already agreed between LPS SR, š.p. and EUROCONTROL has not been included due to the fact that the main aim of this paper was to provide the overview of the future work goals – route optimization. The authors believe that the brief description in the last chapter, where the guidelines for the selection of the relevant sources for the articles/papers etc. has been provided, can serve as a beneficial tool for young researchers, Ph.D. students.

ACKNOWLEDGMENT

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