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Activities of the National Aviation University in "UKRAINE" project of Horizon2020 to foster EGNSS implementation in aviation sphere in Ukraine

Some of the activities of the National Aviation University in "UKRAINE" project of Horizon2020 to foster EGNSS implementation in aviation sphere in Ukraine are describes in this paper.

Introduction of the UKRAINE project

The objective of the UKRAINE (UKraine Replication, Awareness and INnovation based on EGNSS) project [1], in line with *GALILEO-3-2014 Call* of Horizon 2020, was to foster application development through international cooperation and to create a broad acceptance of EGNSS in Ukraine, creating at the same time opportunities both for knowledge building and at commercial level. And one of the expected impacts of the UKRAINE project with respect to the aforementioned objectives was preparation of the Ukrainian aviation market to the extension of EGNOS.

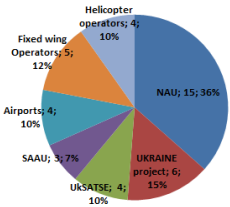
The partnership of the project consists of nine organizations coming from four EU countries and one non-EU country: the coordinator, Valdani Vicari & Associati Srl, Italy; National Aviation University (NAU), Ukraine; TeleConsult Austria GmbH, Austria; Advies de With GCV, Belgium; Nacionalniy Tehnichniy Universitet Ukraini Kiivskiy Politehnichniy Institut, Ukraine; State Space Agency of Ukraine, Ukraine; VVA Europe Limited, United Kingdom; Pildo Consulting SL, Spain; Ovinto CVBA, Belgium.

NAU activities in scope of UKRAINE project

Aviation workshops

Two aviation workshops have been help in NAU: "A PBN Implementation Workshop", April 29, 2015 and "Implementation of EGNOS based approach procedures in Ukraine" March 16, 2016. The main topics discussed during the workshops were the following: GNSS Systems for aviation; Introduction to PBN; Flight Validation of PBN procedures; Advantages of PBN implementation, experience, lessons learned; Ukrainian PBN implementation plan; Experience of NAU in investigation and application of GNSS technologies in Ukraine; GNSS interference monitoring - securing critical infrastructure for aviation; Current state on EGNOS extension to the territory of Ukraine (videoconference call from European Commission), LPV procedures - how to analyze the costs / benefits; The progress of PBN implementation in Ukraine: general overview and challenges.

In addition to presentations, the event also included open discussions and debates between representatives from UkSATSE, NAU, Zhulyany Airport and PildoLabs about different aspects related to PBN implementation and possible cooperation.



The representatives from the following Ukrainian and European organizations participated in the workshop: NAU, Advies de With, TCA, Pildo Labs, KPI, VVA Brussels, European GNSS Agency (GSA), European Commission (EC), Ukrainian State Air Traffic Service Enterprise (UkSATSE), State Aviation Administration of Ukraine (SAAU), International Airport Kyiv (Zhulyany), "MASTER-AVIA" company, "EUROPE AIR" company, Global Air company, Aviation company "Business Jet Travel", Personal Aviation Company "Ukrainian helicopters", State Aviation Enterprise "Ukraine", International airport Odessa.

Fig.1. Participants of the Aviation workshops in NAU

These workshops have been an opportunity for all the attendees (see group photos at fig. 1) to better understand the concept of PBN, the existing references and supporting cells together with the roles of EGNOS within PBN. Its goal was to provide support to Ukraine towards the implementation of EGNSS enabled operations in the civil aviation sector, in particular enhanced by EGNOS, and to establish negotiations with correspondent Ukrainian aviation stakeholders.

The UKRAINE project has obtained a positive feedback from Pieter de Smet (EC) mentioning it is the first research project with important Ukrainian participation in Horizon 2020 research and innovation programme in the area of satellite navigation. The workshops were held in a friendly atmosphere between the participants and laid the foundation for successful implementation of GNSS and EGNOS based approach procedures in Ukraine due to involvement of all important aviation stakeholders at the very beginning stages. It was agreed during the meeting that NAU will be a platform for communication and local coordination at the project level of further activities related to PBN procedures implementation in Ukraine.

RIMS efficient implementation investigation for Ukraine

NAU has performed the analysis of the factors influencing the efficiency of RIMS functioning and the definition of the optimal placement of RIMS at the territory of the Ukraine.

In scope of this task the experimental research of GNSS signal quality was made to define the best position for the RIMS station placement in Kyiv region during the period from January till March 2016. Four potential locations of RIMS implementation have been investigated: Kyiv Zhuliany airport; Main center of special control (Horodok of Zhytomyr region); State Enterprise "KyivPrylad", and NAU.

It has been discovered that the measurement sessions with antennas placed on the roof of high buildings (at State Enterprise "KyivPrylad" and in NAU), had been characterized by slightly higher fluctuations in the signal level and multipath level at low elevation angles of satellites. The measurement sessions on the territory of the airport Kyiv Zhuliany and on the territory of the Main center of the special control contained abnormal portions of measurement. These abnormal measurements have been observed for the satellites with different elevation and azimuth angles, and therefore could not be explained by limited visibility. In the result of analysis if has been defined that the most preferable location for RIMS deployment is the territory of the airport Zhulyany under the condition that additional study should be performed on the detection of the interferences' sources. A bit worse conditions of GNSS signals' reception at the territory of NAU and Horodok. Accommodation of RIMS EGNOS antenna on the roof of the building of "Kievprylad" is considered impractical due to the significant restrictions of satellites visibility.

Analysis of the placement of RIMS stations in the WAAS and EGNOS [2, 3] networks has shown that the distance between stations, placed in effective range, is about the same, ranging from 450 to 800 km. The smaller distance is due to the terrain difficulties, which forces to place the stations closer, than expected. After analyzing the topology of RIMS stations in WAAS and EGNOS networks, and using the PEGASUS and SBASSimulator software, the number and best position for RIMS stations on the territory of Ukraine has been defined. The optimal variant of RIMS placement is Kyiv – Kharkiv – Mariupol (fig. 2). Such configuration provides full coverage of EGNOS service area for Ukraine.

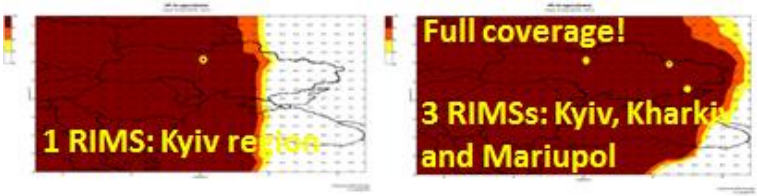


Fig.2. Results of simulation with 1 and 3 RIMSs EGNOS stations in Ukraine

Fig.3. Measurement sites for RIMS optimal place investigation: Zhuliany airport and Boryspil airport

During the period from January till March 2016 the works on definition the place of RIMS EGNOS implementation in Kyiv region of Ukraine have been performed. In scope of these works the measurement sessions in potential RIMS locations have been performed and the measurement information has been analyzed. Five potential locations of RIMS implementation have been investigated: Zhuliany and Boryspil airports (fig. 3); Horodok of Zhytomyr region; State Enterprise "KyivPrylad", and the territory of NAU.

Analysing the measurements at airports it should be aid that the restrictions to the signals receptions were absent; the receiver tracked all planned satellites. Typically, the average signals multipath level didn't exceed 45 cm at the L1 and L2 frequencies. The maximum value of multipath levels at low elevation angles did not exceed 1.5 m. These two positions could be considered as candidates for RIMS host places.

Analysis of the possibility of generic materials adaptation for ANSPs and airports for Ukraine

The growth of aviation and the urgent need to reduce fuel consumption and emissions demand increased airspace and airport capacity and a focus on providing the preferred trajectory (route and altitude) to each aircraft. Aircraft operators also require efficiency gains via approaches with the lowest possible minima and the significant safety benefits of vertical guidance. In fact, controlled flight into terrain (CFIT), in the absence of vertical guidance, is still a frequent accident category, at least for some segments of the aviation community. Another key goal is to reduce the effects of airport noise on populated areas. GNSS-based services can meet these goals and have already provided significant safety and efficiency benefits to aircraft operators. The PBN Manual (Doc 9613) [4] together with other generic materials of ICAO, EUROCONTROL, EASA, CANSO provide the guidance necessary to implement GNSS-based navigation services.

NAU has developed the report, which presents the results of the analysis of generic materials of ICAO, EUROCONTROL, EASA, CANSO and other aviation bodies with the guidelines for Air Navigation Service Providers (ANSPs) and Airports how to implement the RNP APCH procedures starting from NPA based on GNSS only and then down to LPV minima, which could be as low as 200 ft, with the aim to ensure harmonized solutions and a common approach according to the Single European Sky (SES) Regulation.

PBN Best Practice Guide for ANSPs [5] summarized the benefits for the main stakeholders: airports – improved access, potential for reduced infrastructure costs, community economic benefits, environmental benefits; ANSPs – improvements in safety, reduced service costs, service improvements; airlines – enhanced safety, improvements in efficiency, better schedule reliability, opportunities for broad cost reductions, reductions in CO_2 footprint; communities – environmental benefits such as reduced impact from aviation operations via CO_2 emissions and noise exposure; also reduced passenger airfares, flight times, and flight diversion disruptions.

In scope of this report the analysis of flight plans for major Ukrainian airports for the period from January 2015 to May 2016 have been done to identify

the percentage of flights with capability to perform RNP APCH. At the fig. 3 it can be seen the example of such analysis for Boryspil airport for 2015 year.

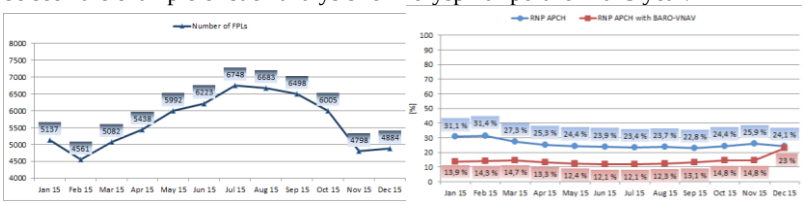


Fig.3. Boryspil airport statistics for 2015 year: general number of flight plans (left part); percentage of flights with RNP APCH capability (right part)

The analysis of the flight plans of major Ukrainian airports has shown that the average number of flights in all analyzed airports, except Kharkov, has decreased in 2016 compared to 2015 year, but despite this the percentage of readiness of operators to use PBN capable approaches for airports RNP APCH in 2016 tends to growth.

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Conclusion

NAU actively participated in different tasks of "UKRAINE" project of Horizon2020. Some of its activities have been described in this paper. The project in general and NAU facilitated a bit the preparation of the Ukrainian aviation market to the extension of EGNOS.

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