NAU activities in UKRAINE project to foster EGNSS implementation in aviation sphere in Ukraine

*Workshop “EGNSS Commercial and R&D opportunities in Ukraine”*
03 June 2016, Hague (Netherlands)

Reporter: Svitlana Ilnytska, PhD Technical Sciences, Senior Researcher, National Aviation University
UKRAINE’s Project Objectives, Impacts expected and Actions to be done (Aviation sector)

• The objectives: to foster application development through international cooperation, to create broad acceptance of EGNSS in Ukraine, to create the opportunities both for knowledge building and commercialization.

• Impacts expected: Preparation of the Ukrainian aviation market to the extension of EGNOS

• Working on Aviation as the starting point for the extension of EGNOS to Ukraine through the following set of actions:
Negotiation activities with Ukrainian Aviation Stakeholders and Project Partners

National Aviation University

UkSATSE

Zhuliany Airport

SAAU

International Airport KYIV

TeleConsult

AUSTRIA

PildoLabs

move smart
Aviation workshops in NAU (2015, 2016)

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 (UkJSATSE), 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.

16 March 2016

29 April 2015
RAiSG had been established by EUROCONTROL to coordinate the activities necessary for the implementation of RNAV approaches in the European Civil Aviation Conference (ECAC) area and to monitor implementation status. RAiSG 9 - EUROCONTROL, Brussels, 12-13 November 2015; RAiSG 10 - EUROCONTROL, Brussels, 11-12 May 2016.
OVERVIEW OF NATIONAL PBN IMPLEMENTATION PLAN
Formal basis for PBN implementation in Ukraine

Generic European materials

- ICAO Assembly Resolution A37-11 — PBN global goals, November 2010.
- ICAO CIRCULAR 267-AN/159 Guidelines for the introduction and operational use of the global navigation satellite system (GNSS)
- PBN Best Practice Guide for ANSPs. Civil Air Navigation Services Organisation (CANSO), 2015
- EGNOS How to obtain RNP APCH operational approval to LPV minima in Europe / ESSP, GSA // October 2015. – 33 p.

Ukrainian documents

- Local Single Sky ImPlementation (LSSIP) UKRAINE, LCIP, Years 2015-2019 – Level 1, Edition Date: 15/06/15.
Ukraine Membership in different International Aviation related Organizations

- **1992** - Ukraine became the Full Member State of International Civil Aviation Organisation (ICAO).
- **1999** - Ukraine became the Member State of European Civil Aviation Conference (ECAC).
- **2004** - Ukraine became the 33rd Member State of EUROCONTROL.
- **18 January 2016** - EASA and the State Aviation Administration of Ukraine (SAAU) concluded a new Working Arrangement (WA)

Ukraine is a member of:
- **IFATCA** – from 1994
- **CANSO** – from 1998
- **IFATSEA** – from 2000
Ukrainian PBN implementation taskforce

Order of SAAU from 02.06.2015 #291 “About introducing changes in composition of the work group on realization activities of the National PBN implementation plan”:

• State Aviation Administration of Ukraine,
• Ukrainian State Air Traffic Service Enterprise,
• Ukraine International Airlines,
• KYIV/Borispil’ International Airport,
• National Aviation University,
• Antonov Design Bureau.
Classification of Ukrainian aerodromes

• High traffic density, being mainly international operations
  KYIV (Boryspil’) [UKBB] (1)

• Medium traffic density, being mainly international operations
  Dnipropetrovs’k [UKDD], Donets’k [UKCC], Kharkiv (Osnova) [UKHH], KYIV (Zhuliany) [UKKK], L’viv [UKLL], Odesa [UKOO], Simferopol’ [UKFF] (7)

• Low traffic density / domestic
  Chernivtsi [UKLN], Ivano-Frankivs’k [UKLI], Luhans’k [UKCW], Mariupol’ [UKCM], Mykolaiv [UKON], Rivne [UKLR], Uzhhorod [UKLU], Vinnytsa (Gavryshivka) [UKWW], Poltava [UKHP], Sevastopol’ (Bel’bek) [UKFB], Sumy [UKHS] (11)

• Cargo Operations/Test Flights
  Kryvyi Rih (Lozuvatka) [UKDR], KYIV (Antonov-1) [UKKT], KYIV (Antonov-2) [UKKM], Lymans’ke [UKOM], Dzhankoi [UKFY], Kirovohrad [UKKG], Kremenchuk (Velyka Kokhnivka) [UKHK], Kharkiv (Sokolnyky) [UKHD], Zaporizhzhia (Mokraya) [UKDE] (9)

• GA/Sport/AFIS (in accordance to AIC A 08/11 effective 16 DEC 2011)
  Cherkasy [UKKE], Kerch [UKFK], Khmel’nyc’kyi [UKLH], Ternopil’ [UKLT], Berdians’k [UKDB], Simferopol’ (Zavods’ke) [UKFW], Zhytomyr (Ozerne) [UKKO], Severodonets’k [UKCS]
# Terminal Airspace - General Planning

<table>
<thead>
<tr>
<th>Group</th>
<th>Short-term</th>
<th>Medium-term</th>
<th>Long-term</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>International high traffic density/Hub</strong></td>
<td>RNAV 1 (conventional procedures maintained)</td>
<td>RNAV 1 mandatory Introduction of A-RNP</td>
<td>A-RNP mandatory</td>
</tr>
<tr>
<td><strong>International medium traffic density</strong></td>
<td>RNAV 1 (conventional procedures maintained)</td>
<td>RNAV 1 mandatory</td>
<td>Introduction A-RNP</td>
</tr>
<tr>
<td><strong>Low to medium traffic density/Domestic</strong></td>
<td>RNAV 1 (conventional procedures maintained)</td>
<td>RNAV 1 mandatory</td>
<td>Introduction A-RNP</td>
</tr>
<tr>
<td><strong>Cargo Operations/Test Flights</strong></td>
<td>Conventional procedures</td>
<td>RNAV 1</td>
<td>RNAV 1 maintained</td>
</tr>
<tr>
<td><strong>GA/Sport/AFIS</strong></td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>
## Terminal Airspace - Key international aerodromes

<table>
<thead>
<tr>
<th>Airport</th>
<th>Short-term</th>
<th>Year</th>
<th>Medium-term</th>
<th>Year</th>
<th>Long-term</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Donets’k</td>
<td>RNAV 1  (31 May 2012)</td>
<td>1st Qua 2012</td>
<td>RNAV 1 mandatory</td>
<td>2017*</td>
<td>Introduction A-RNP</td>
<td>t.b.d.</td>
</tr>
<tr>
<td>Kharkiv</td>
<td>RNAV 1  (03 May 2013)</td>
<td>Mid 2012</td>
<td>RNAV 1 mandatory</td>
<td>2018*</td>
<td>Introduction A-RNP</td>
<td>t.b.d.</td>
</tr>
</tbody>
</table>
## Approach Operations

<table>
<thead>
<tr>
<th>Airport Type</th>
<th>Short-term now – 2015</th>
<th>Medium-term 2016 - 2019</th>
<th>Long-term 2020+</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>International airport</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High traffic density</td>
<td>NPA</td>
<td>APV SBAS-VNAV</td>
<td>GBAS CAT I</td>
<td>Implementation depends on the level of aircraft equipage (present and future) operating to/from the specific airport.</td>
</tr>
<tr>
<td><strong>International airports</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medium traffic density</td>
<td>NPA</td>
<td>APV Baro-VNAV</td>
<td>APV SBAS-VNAV</td>
<td></td>
</tr>
<tr>
<td>Domestic airports</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low traffic density</td>
<td>NPA</td>
<td>APV Baro-VNAV</td>
<td>APV SBAS-VNAV</td>
<td></td>
</tr>
<tr>
<td>Cargo &amp; Business airports</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low traffic density</td>
<td>NPA</td>
<td>APV Baro-VNAV</td>
<td>APV SBAS-VNAV</td>
<td></td>
</tr>
<tr>
<td><strong>GA/Sport/AFIS</strong></td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
</tbody>
</table>
## Aerodromes analysis

<table>
<thead>
<tr>
<th>Aerodrome List</th>
<th>Aerodrome traffic mixture (%)</th>
<th>Aerodrome Figures (%)</th>
<th>Runway Infrastructure (%)</th>
<th>EGNOS coverage (%)</th>
<th>Stakeholders strategy (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Big commercial A/C (%)</td>
<td>Regional A/C (%)</td>
<td>Others (%)</td>
<td>Traffic density</td>
<td># RWYS</td>
</tr>
<tr>
<td>KYIV (Boryspil) [UKBB]</td>
<td>75,0%</td>
<td>15,0%</td>
<td>5,0%</td>
<td>High</td>
<td>2</td>
</tr>
<tr>
<td>DNIPROPETROVSK [UKDD]</td>
<td>60,0%</td>
<td>35,0%</td>
<td>5,0%</td>
<td>Medium</td>
<td>1</td>
</tr>
<tr>
<td>KYIV (Zhuliany) [UKKK]</td>
<td>60,0%</td>
<td>35,0%</td>
<td>5,0%</td>
<td>Medium</td>
<td>1</td>
</tr>
<tr>
<td>LVIV [UKLL]</td>
<td>60,0%</td>
<td>35,0%</td>
<td>5,0%</td>
<td>Medium</td>
<td>1</td>
</tr>
<tr>
<td>ODESA [UKOO]</td>
<td>60,0%</td>
<td>35,0%</td>
<td>5,0%</td>
<td>Medium</td>
<td>1</td>
</tr>
<tr>
<td>IVANO-FRANKIVSK [UKLU]</td>
<td>10,0%</td>
<td>40,0%</td>
<td>50,0%</td>
<td>Low</td>
<td>1</td>
</tr>
<tr>
<td>MYKOLAIV [UKON]</td>
<td>10,0%</td>
<td>40,0%</td>
<td>50,0%</td>
<td>Low</td>
<td>1</td>
</tr>
<tr>
<td>RIVNE [UKLR]</td>
<td>10,0%</td>
<td>40,0%</td>
<td>50,0%</td>
<td>Low</td>
<td>1</td>
</tr>
<tr>
<td>UZHHOROD [UKLU]</td>
<td>10,0%</td>
<td>40,0%</td>
<td>50,0%</td>
<td>Low</td>
<td>1</td>
</tr>
<tr>
<td>VINNYTSA (GAVRYSIVKA) [UKWW]</td>
<td>10,0%</td>
<td>40,0%</td>
<td>50,0%</td>
<td>Low</td>
<td>1</td>
</tr>
<tr>
<td>POLTAVA [UKHP]</td>
<td>10,0%</td>
<td>40,0%</td>
<td>50,0%</td>
<td>Low</td>
<td>1</td>
</tr>
<tr>
<td>Cherkasy [UKKE]</td>
<td>0,0%</td>
<td>0,0%</td>
<td>100,0%</td>
<td>GA/Sport</td>
<td>1</td>
</tr>
<tr>
<td>KHIMELNYTSKYI [UKHL]</td>
<td>0,0%</td>
<td>0,0%</td>
<td>100,0%</td>
<td>GA/Sport</td>
<td>1</td>
</tr>
<tr>
<td>TERNOPIL [UKLT]</td>
<td>0,0%</td>
<td>0,0%</td>
<td>100,0%</td>
<td>GA/Sport</td>
<td>1</td>
</tr>
<tr>
<td>ZHYTOMYR (OZERNE) [UKKO]</td>
<td>0,0%</td>
<td>0,0%</td>
<td>100,0%</td>
<td>GA/Sport</td>
<td>1</td>
</tr>
</tbody>
</table>
Flight Plans analysis regarding RNP APCH capability for Zhuliany airport
The research on RIMS efficient implementation at the territory of Ukraine

1. NAU together with other representatives from Ukrainian side participated in the video conferences (14.12.2015 and 25.01.2015) at the premises of SSAU with GSA and EC representatives. This video conferences where devoted to the discussion of the proposed by SSAU places for RIMS installation to the conditions of high level, provided by GSA.

2. Analysis of location of existing RIMS stations: 13 of them are placed at the airports.

3. Theoretical explanation and practical implementation of geometrical method for RIMS stations possible installation area determination

4. Method of performing quality analysis of measured GNSS information and its practical application have been performed.

5. EGNOS monitoring activity: September 2015 – till now.
The research on RIMS efficient implementation: Horodok, Kyivprylad, Zhuliany and NAU

Measurements at Horodok (80 km from Kyiv)

Measurements at Zhuliany airport

Measurements at Kyivprylad

Measurements at NAU polygon
The preliminary analysis shows that the most preferable place for RIMS location is the territory of the airport Zhulyany under the condition that additional study should be performed on the analysis of radio interferences (sources, nature, etc.).

A bit worse conditions of GNSS signals reception at the National Aviation University and at Horodok.

Accommodation RIMS EGNOS antenna on the roof of the building of "Kievprybor" is considered impractical due to the significant restrictions in satellites visibility.

<table>
<thead>
<tr>
<th>Location</th>
<th>Visibility limitations</th>
<th>Presence of anomalies</th>
<th>Level of multipath</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zhuliany airport</td>
<td>Absent</td>
<td>Present</td>
<td>Normal</td>
</tr>
<tr>
<td>Horodok</td>
<td>There are some at south part</td>
<td>Present</td>
<td>Increased at low elevation angles at south direction</td>
</tr>
<tr>
<td>Kyivprylad</td>
<td>Sufficient limitations at east, south-east and south directions</td>
<td>Absent</td>
<td>Increased at low elevation angles at east, south-east and south directions</td>
</tr>
<tr>
<td>NAU</td>
<td>Absent</td>
<td>Absent</td>
<td>Normal. Insufficiently increased at low elevation angles</td>
</tr>
</tbody>
</table>
Scheme of signal-to-noise ratio measurement

1- PRN 120
2- PRN GPS
3- PRN 136

4- Interference source
5- ANTENNA GNSS
6- Interface
7- PC+ PEGASUS

Noise jammer
GNSS receiver and antenna
GNSS antennas at NAU polygon
EGNOS monitoring at NAU polygon

EGNOS measurements at NAU polygon: start 08 September 2015 – till now
http://asc.nau.edu.ua/

This research is performed under the UKRAINE project. UKRAINE (http://www.project-ukraine.eu/) is an H2020 Innovation Action (under H2020-Galileo-2014-1 call) supported by the EC through grant № 641517.

Automatically generated PEGASUS report for the data, recorded on 2nd March 2016 in the satellite systems laboratory in NAU.
You can download it in pdf here.
Processing GNSS signal without disturbances

18495 valid epochs, 1379 unavailable epochs and 0 (H)MI epochs:

Unavailability epochs: 1379

Normal Operations:
(CAT-1, APV-2 and APV-1)
17118 Epochs

Signal To Noise Ratio

SNR Elevation
Processing GNSS signal with not critical disturbance

22284 valid epochs, 1517 unavailable epochs and 0 (H)MI epochs:

Unavailability epochs: 216

Normal Operations:
(CAT-1, APV-2 and APV-1)
20767 Epochs

No PA: 1301

hpe (m)

2 4 8 12 20 30 40 50

hpl (m)

4 8 12 16 20 24 30 40 50

L1 CNo

signal to noise ratio (dBHz)

SNR Elevation

signal to noise ratio (dBHz)

Elevation

Generated by Luxeo-ControlGNSS

PRN

EGNOS evolution: measurements in Kyiv

IGP Availability

2009 year

2010 year

2012 year
Average HPL Map from the EGNOS Service Volume Simulator
Simulation results: HPL LPV-200 availability maps, different scenario

KIY RIMS station

KIY and MAR RIMS stations

KIY and KHA RIMS stations

KIY, KHA and MAR station
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03 June 2016, Hague (Netherlands)

THANK YOU FOR YOUR ATTENTION!

Presented by Svitlana Ilnytska, e-mail: svetlana-ilnicka@yandex.ua

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