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POLFRA - FREE ROUTE AIRSPACE IN WARSAW FIR

Feasibility Study

Edition Number : Version 1.0
Edition Validity Date : 10/07/2018

EUROCONTROL

DOCUMENT CHARACTERISTICS

Document Title	Document Subtitle (optional)	Edition Number	Edition Validity Date
POLFRA - FREE ROUTE AIRSPACE IN WARSAW FIR	Feasibility Study	Version 1.0	10/07/2018
Abstract			
Author(s)			

Contact Person(s)	Tel/email	Unit

STATUS AND ACCESSIBILITY			
Status		**Accessible via**	
Working Draft	☐	Intranet	☐
Draft	☐	Extranet	☒
Proposed Issue	☒	Internet (www.eurocontrol.int)	☐
Released Issue	☐		

TLP STATUS		
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White	☐	Public information

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Where document approval is made via a meeting or electronic workflow, the details shall be indicated here in place of the approval table.

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Edition History

The following table records the complete history of the successive editions of the present document.

Edition History

Edition No.	Edition Validity Date	Author	Reason
0.1	04/05/2018	EUROCONTROL NMD/OPL	Initial Draft
0.2	14/05/2018	EUROCONTROL NMD/OPL	Initial Results
0.3	28/05/2018	EUROCONTROL NMD/OPL	Proposed Version
0.4	05/06/2018	EUROCONTROL NMD/OPL	Integrated Version
0.5	15/06/2018	EUROCONTROL NMD/OPL	Final Comments from PANSA
1.0	10/07/2018	EUROCONTROL NMD/OPL	Proposed Version from NM

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EXECUTIVE SUMMARY

This document contains results of the feasibility study performed by EUROCONTROL NMD/OPL on request of PANSA representatives in support of implementation of POLFRA project – Phase 1.

The POLFRA project aims to implement Free Route Airspace - FRA operations within airspace of Warsaw FIR in two phases:

- Phase 1 - at national level; on permanent basis – H24 at FL095 and above.
- Phase 2 - regional cross-border implementation.

Based on the results of the study it could be concluded that implementation of POLFRA project – Phase 1, has potential to bring estimated benefits for the Airspace users in the order of Magnitude saving 1 650 000 NMs per annum.

Benefits for the ANSPs in terms of predictability and moving planning of operations closer to what is really flown, in coordination between the ACC sectors involved – thus could also have potential to bring benefits from reduction in ATCO coordination workload.
To maximize potential benefits for all partners across the network, it is highly recommended to consider further expansion of the Cross-border FRA operations and in that respect to plan next Phases of the project (Phase 2 - regional cross-border implementation) to:

- Expand cross-border FRA operations with Lithuania in the scope of the Baltic FAB but more over to expand cross-border FRA operations to include potentially Bratislava ACC, SEE FRA initiative, Ukraine ACCs but also other adjacent ACCs and partners e.g. LFV Sweden and DFS Germany.

1. INTRODUCTION

1.1. TRAFFIC DEMAND

Traffic demand from 01. July 2017 is used for all scenarios.

1.2. BASELINE AIRAC

In the SAAM model SAAM Dataset AIRAC 1804 is used as a baseline.

1.3. STUDY Areas

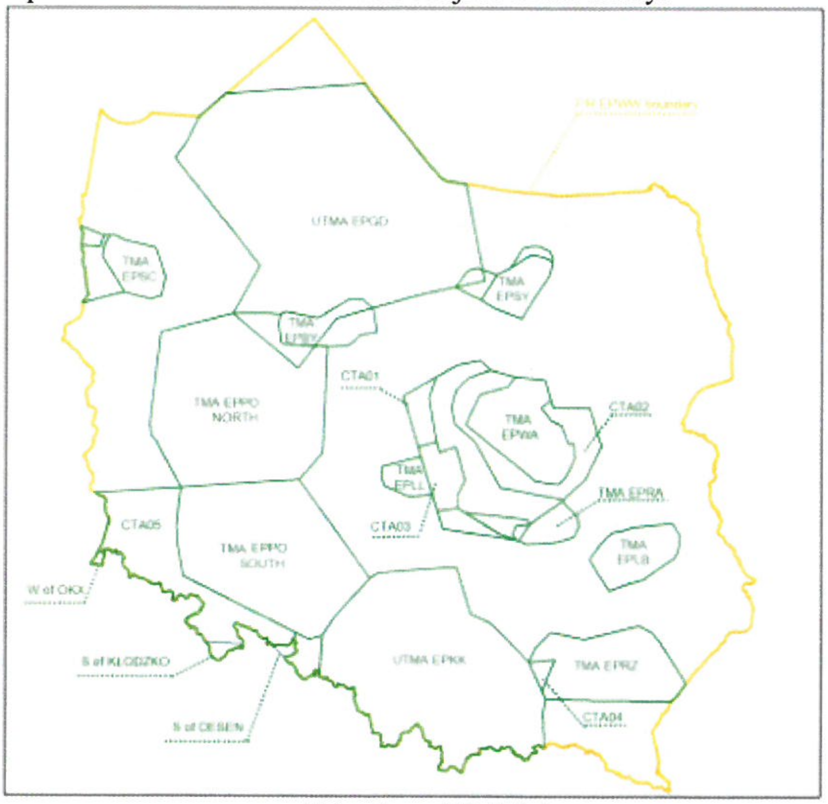
For this study Warsaw FIR has been included.

1.4. Military Activity

For the SAAM Data validation, MIL OFF - situation without Military activity is studied. All CDRs (CDR 1 and CDR2) are considered open.

1.5. AREA

Picture below depicts POLFRA AoR that was subject of the study.



Picture 1 : POLFRA Area

1.6. Sectors

Elementary sectors of POLFRA from AIRAC 1804, (without opening scheme and collapse sectors) analysed in the study are listed below:

EPWW CTA: All elementary sectors

1.7. FREE ROUTE – SAAM model

For generating free route trajectories in the SAAM model, the original traffic demand has been used. Assignment was made on the shortest distance option between origin and destination with use of the all-existing RAD and FRA points' (E, X, I, D and A) defined in the model. The Free Route process calculates a straight trajectory between entry and exit point for the Free Route Airspace.

1.7.1. Free Route Airspace POLFRA, concept of operation (CONOPS)

1.7.2. FRA general procedures

The application of Free Route Airspace concept encompasses the horizontal boundaries of POLFRA area in Class C airspace which will be published in AIP Poland. Free Route Airspace concept is not applied in the airspace of TMAs, CTRs and class G airspace.
Free Route Airspace in Warsaw FIR is applicable H24 in the airspace of POLFRA area (as published in AIP Poland) from FL95 to FL660.

1.8. FRA Entry (E) and eXit (X) POINTS rules

Entry and exit to and from POLFRA area shall be performed only via the points published and defined as FRA Entry, FRA Exit or FRA Entry / Exit in AIP Poland ENR 4.4.1.
These points will retain their functions from ATS route network operations or adjacent FRAs (e.g. points which are entry-only remain entry-only in FRA). Dedicated FRA Entry or FRA Exit or FRA Entry / Exit normally will not be published, unless required by specific operational conditions and bilaterally agreed with adjacent ATC units.

1.9. FRA Intermediate (I) points rules

Airspace users may file in their FPL FRA Intermediate points between FRA Entry, FRA Exit and FRA Entry / Exit points in order to wind optimize their profile, circumnavigate a particular area, indicate a change in flight level, flight rules or speed, or remain compliant with FIR boundaries rules (see paragraph 5.4).
A FRA Intermediate point could be any significant point - en-route radio navigation aid or 5LNC published in AIP Poland, ENR 4.4.1 respectively.
There is no restriction on the number of FRA Intermediate points used.
The use of unpublished FRA Intermediate point defined by geographical coordinates or by bearing and distance in FPL Item 15 is not allowed. Arbitrary points defined by bearing and distances in FPL Item 15 are allowed only for indication of flight level or speed change.

1.10. FRA Arrival (A) and Departure(D) connecting points rules

Flights arriving at airports located within the limits of Warsaw FIR (EP.. airports) may plan their flights according FRA rules up to a published FRA Arrival connecting point. Then they must continue via ATS route network (or a specific connecting route) until the entry point of the TMAs. The FRA Arrival connecting point may coincide with a TMA (or CTR) entry point.

Flights departing from airports located within the limits of Warsaw FIR (EP.. airports) must plan their flights via ATS route network (or a specified connecting route) from the exit point of the TMA up to a published FRA Departure connecting point. After that point they may plan according to FRA rules. A FRA Departure connecting point may coincide with a TMA exit point.

1.11. FIR boundary rules

Segments between FRA Entry, FRA Intermediate and FRA Exit points shall remain fully contained within published POLFRA area. Flight plans with segments that partially cross the lateral limits of POLFRA area will be rejected by IFPS. Whenever exceptions apply they will be published in AIP and RAD.
The planning of segments closer than 5 NM to the POLFRA horizontal border is not allowed. Flight plans containing segments that pass close to Warsaw FIR boundary might be tactically re-routed when required in order to ensure sufficient safety lateral buffer from extraneous airspace, unless otherwise coordinated with the adjacent ATC unit.

1.12. ATS route network and FRA airspace

The ATS route network within Warsaw FIR will remain available for flight planning by those airspace users which are not eligible or do not want to flight plan direct routes or for emergency cases.

1.13. Scenarios

PANSA has committed to make available permanent free route operations from 28 February 2019, this project is named POLFRA.
Even if the POLFRA implementation starts at the national level, some of the main aspects of POLFRA are expected to be better solutions for airspace design, new airspace operating concepts and enhanced operational performance.
The airspace design solutions and airspace operating concepts need to be viewed from the pan-European network perspective and not just from the regional one. Therefore the regional aspects, like the FRA implementations and changes within the neighbouring ACCs (Bratislava ACC and SEE FRA) have been assessed with the POLFRA validation in scenario 2. The regional level validation scenarios are aimed to demonstrate the positive impact the POLFRA scenario.

Assignment for REF, SC1, SC2 and SC3 scenarios:

1.13.1.REF:

REF:

- Current situation by AIRAC1804;

1.13.2.Assigned traffic,

1.13.3.SC1: POLFRA H24

- Assigned traffic

- POLFRA H24 FL095+

1.13.4.SC2: POLFRA H24 + BRAFRA H24 + SEEFRA H24

- Assigned traffic
- POLFRA H24 FL095+
- BRAFRA in Bratislava ACC (LZBB) FL245+ and H24; SEE FRA; H24; various DFLs (FL095+-125+

1.14. Comparison

1.14.1.REF – SC1:

- Delta sector load;
- Delta trajectory;
- Scenario economy (distance, fuel, CO2, NOx).

1.14.2.REF – SC2:

- Delta sector load;
- Delta trajectory;
- Scenario economy (distance, fuel, CO2, NOx).

1.15. SAAM – Tool

SAAM - **S**ystem for **A**nalysis and **A**ssignment at a **M**acroscopic level, is an analysis tool at macroscopic level developed at EUROCONTROL Headquarters to assess and validate various airspace structures. The tool is widely used in support of the work of the Route Network Development Sub-Group (RNDSG) and its use spreads currently to other areas like EUROCONTROL CRCO, CFMU, EEC, FABs etc.
The ability to test different traffic distributions, different route networks (additional route options), different sector configurations or a combination of the three naturally designates SAAM to measure the impact and potential benefits of a proposed airspace structure.
The tool provides data in form of maps and graphs, traffic loading on individual segments of the route network and sector loads within a specified volume of airspace.
SAAM's quick response time and user-friendly graphical interface means that it is possible to quickly reconfigure airspace structure, and test alternative proposals. This allows the evaluation of a wide range of scenarios before the most promising ones are developed further and assessed through Fast-Time Simulation and/or Real-Time Simulation tools.

1.15.1. Description of SAAM methodology

1.15.1.1. Current Traffic

For the required day of operation a file was extracted from the CFMU records containing all flight plans for completed flights which is called "**current traffic sample**".

1.15.1.2. Traffic Demand

The current traffic sample is processed with SAAM and the created file called "**traffic demand**" is used as an input to the assignment process. The traffic demand contain only a number of the initial parameters of the flights: flight ID, type of aircraft, departure time, maximum requested flight level, airport of departure and airport of arrival.

1.15.1.3. Traffic Assignment (assigned traffic)

Using SAAM, to find routes on a given network for a given traffic demand, is process called Assignment, and by default the routes found are the shortest. Using SAAM the process of traffic assignment can be summarised as follows:

1. Using the traffic demand a 2D trajectory file is processed considering different parameters: rules (RAD restriction, arrival/departure routes and wind), airport coordinates, SID/STAR points for an airport and used RFL (from flight plan).
2. This processed 2D trajectory file is the traffic demand assigned on the shortest route between the airport of departure and airport of destination on a given route network.
3. From this 2D file a 4D trajectory file is processed called "**assigned traffic**" adding time and flight level to each route point considering constraints data (departure and/or arrival and/or cruising flight level constraints for any flight or set of flights).

1.15.1.4. Scenario economy

Compare length, time, fuel, CO_2 and NOx emission of two traffic files. All flights present in both traffic samples where some airspace changes were applied are processed. The scenario economy analysis is designed to work with simulated traffic samples containing entire trajectories.
The two input traffic samples, the reference and the scenario, are generally taken from the same day of traffic. The flights are identified with their flight ID. Only the flights present in both input files are analysed. The TMA exclusion is 40NM.
As usual, it is strongly recommended to build your scenario (=after situation) on a clean and stable reference (=before situation), so that the comparison between the reference and the scenario will fairly reflect your changes and only your changes.

2. COMPARISON REF - SC1

2.1. REF VS SC1: Delta trajectory

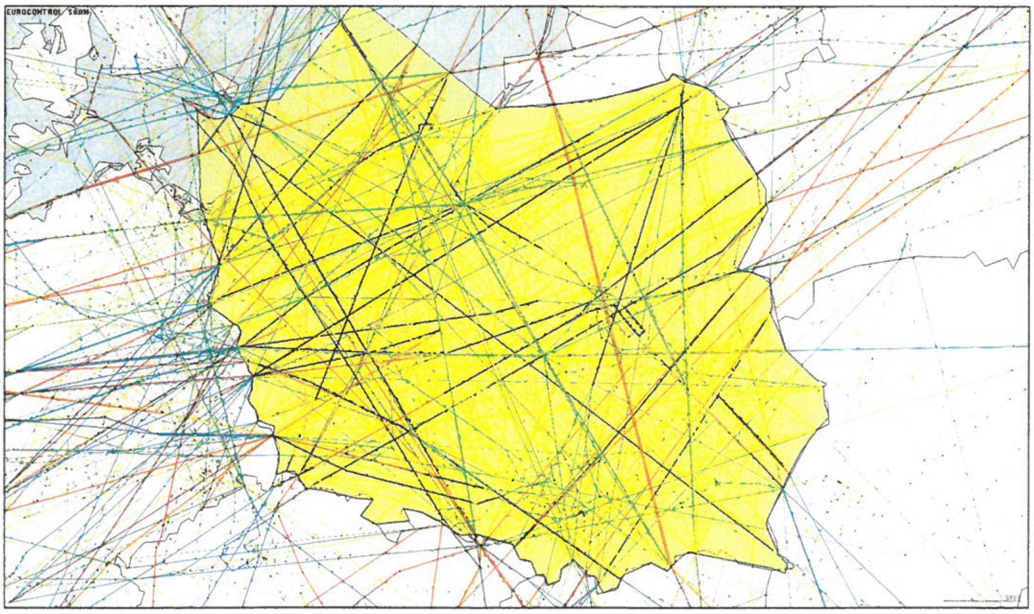
Reference

Distance Ranges (NM)	Number of flights	Route Distance (NM)	Direct Distance (NM)	Extension (%)
[0 - 150 [	95	7610,061355	7521,271135	1,18%
[150 - 300 [	119	26697,61732	25811,9038	3,43%
[300 - 500 [	216	87970,85127	85686,44569	2,67%
[500 - 800 [	510	336836,5298	330557,0334	1,90%
[800 - 1200 [	751	746865,4296	727056,0677	2,72%
[1200 - more [	1012	2513971,212	2453182,141	2,48%
Total	2703	3719951,701	3629814,863	2,48%

Scenario

Distance Ranges (NM)	Number of flights	Route Distance (NM)	Direct Distance (NM)	Extension (%)
[0 - 150 [	94	7556,951423	7445,170671	1,50%
[150 - 300 [	119	26626,35531	25816,61814	3,14%
[300 - 500 [	217	87917,84616	86083,40775	2,13%
[500 - 800 [	519	343160,0144	337790,0717	1,59%
[800 - 1200 [	743	739560,7007	721530,3668	2,50%
[1200 - more [	1010	2509754,602	2451027,978	2,40%
Total	2702	3714576,47	3629693,613	2,34%

Table 1: Route length comparison REF vs. SC1



Picture 2 : Delta trajectory REF – SC1

2.2. REF VS SC1: Delta sector load

Sector	REF	SC1	Delta REF vs SC1
EPWWGH	281	238	-43
EPWWRH	320	297	-23
EPWWEL	468	449	-19
EPWWRL	403	392	-11
EPGDTA	124	119	-5
EPKKTA	173	168	-5
EPWWCH	215	213	-2
EPWAN	182	182	0
EPRATA	1	1	0
EPLRAZ	1	1	0
EPSCTA	14	14	0
EPLBCR	17	17	0
EPPOTAN	77	77	0
EPBYCR	5	5	0
EPSYTA	3	3	0
EPLLTA	11	11	0
EPKTCR	45	45	0
EPZGCR	1	1	0
EPWWFIS	44	44	0
EPRZCR	19	20	1

Sector	REF	SC1	Delta REF vs SC1
EPRZTA	21	22	1
EPLBTA	17	18	1
EPPOTAS	76	80	4
EPWWGL	247	251	4
EPWAS	549	554	5
EPWWFL	108	116	8
EPWWNL	204	213	9
EPWWEH	187	197	10
EPWWNH	156	170	14
EPWWBL	283	301	18
EPWWCL	376	398	22
EPWWDL	338	361	23
EPWWDEH	137	165	28
EPWWTL	359	390	31
EPWWTWH	337	368	31
EPWWTEH	99	133	34
EPWWJL	432	472	40
EPWWJH	344	400	56
EPWWBH	341	406	65
EPWWFH	135	206	71
EPWWDWH	311	386	75

2.3. REF VS SC1: Scenario economy

(Distance, fuel, CO2, NOx)

Scenario Economy for ... (Potential gains/losses)					
Total impacted flights	Length (NM)	Time (min)	Fuel (kg)	CO2 (kg)	NOx (kg)
1589	-5908,680	-823,754	-36351,226	-114874,424	-494,125

Table 2: Scenario economy REF vs. SC1

3. COMPARISON REF – SC2

3.1. REF VS SC2: Delta trajectory

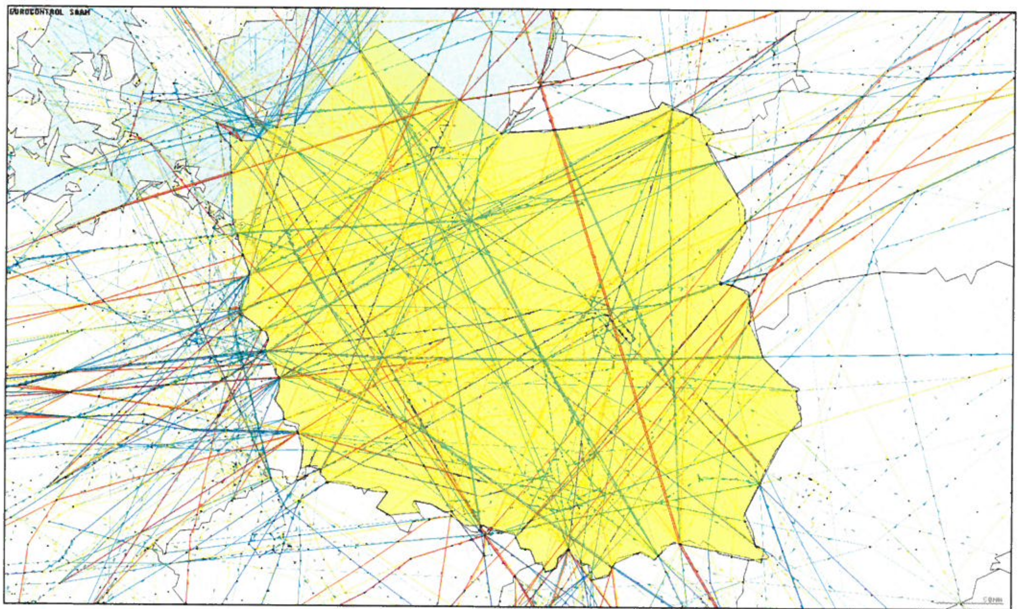
Reference

Distance Ranges (NM)	Number of flights	Route Distance (NM)	Direct Distance (NM)	Extension (%)
[0 - 150 [	95	7610,061355	7521,271135	1,18%
[150 - 300 [	119	26697,61732	25811,9038	3,43%
[300 - 500 [	216	87970,85127	85686,44569	2,67%
[500 - 800 [	510	336836,5298	330557,0334	1,90%
[800 - 1200 [	751	746865,4296	727056,0677	2,72%
[1200 - more [	1012	2513971,212	2453182,141	2,48%
Total	2703	3719951,701	3629814,863	2,48%

Scenario

Distance Ranges (NM)	Number of flights	Route Distance (NM)	Direct Distance (NM)	Extension (%)
[0 - 150 [	94	7556,951423	7445,170671	1,50%
[150 - 300 [	119	26620,14531	25816,61814	3,11%
[300 - 500 [	216	87377,88148	85592,02678	2,09%
[500 - 800 [	520	343491,6675	338227,2423	1,56%
[800 - 1200 [	741	737207,822	720319,2289	2,34%
[1200 - more [	1010	2509329,317	2451026,108	2,38%
Total	2700	3711583,785	3628426,395	2,29%

Table 3: Route length comparison REF vs. SC2



Picture 3 : Delta trajectory REF – SC2

3.2. REF VS SC2: Delta sector load

Sector	REF	SC2	Delta REF vs SC2
EPWWGH	281	237	-44
EPWWEL	468	452	-16
EPWWRL	403	396	-7
EPGDTA	124	119	-5
EPKKTA	173	168	-5
EPRATA	1	1	0
EPWAN	182	182	0
EPLRAZ	1	1	0
EPSCTA	14	14	0
EPLBCR	17	17	0
EPPOTAN	77	77	0
EPSYTA	3	3	0
EPBYCR	5	5	0
EPLLTA	11	11	0
EPKTCR	45	45	0
EPZGCR	1	1	0
EPWWCH	215	215	0
EPWWFIS	44	44	0
EPRZCR	19	20	1
EPLBTA	17	18	1

Sector	REF	SC2	Delta REF vs SC2
EPRZTA	21	22	1
EPPOTAS	76	80	4
EPWWGL	247	252	5
EPWAS	549	554	5
EPWWFL	108	116	8
EPWWNL	204	216	12
EPWWEH	187	204	17
EPWWBL	283	300	17
EPWWCL	376	397	21
EPWWRH	320	343	23
EPWWNH	156	179	23
EPWWDL	338	361	23
EPWWTWH	337	361	24
EPWWTL	359	391	32
EPWWDEH	137	172	35
EPWWTEH	99	142	43
EPWWJL	432	482	50
EPWWBH	341	394	53
EPWWDWH	311	375	64
EPWWFH	135	204	69
EPWWJH	344	421	77

3.3. REF VS SC2: Scenario economy

(Distance, fuel, CO2, NOx)

Scenario Economy for ... (Potential gains/losses)					
Total impacted flights	Length (NM)	Time (min)	Fuel (kg)	CO2 (kg)	NOx (kg)
1805	-6691,480	-927,685	-43621,311	-137844,216	-601,436

Table 4: Scenario economy REF vs. SC2

4. COMPARISON SC1 – SC2

4.1. SC1 VS SC2: Delta trajectory

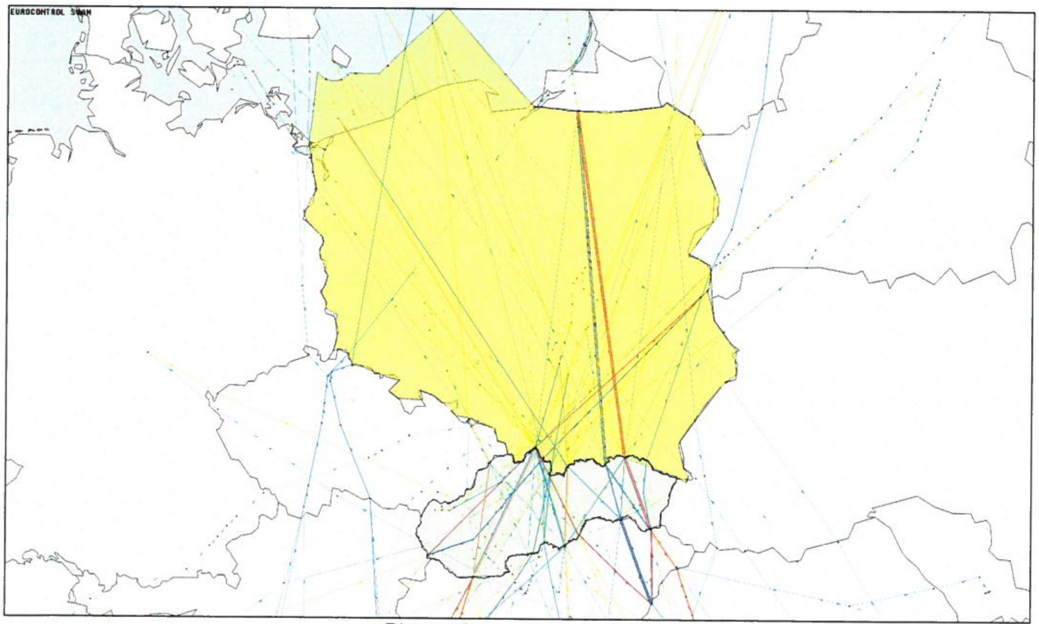
Reference

Distance Ranges (NM)	Number of flights	Route Distance (NM)	Direct Distance (NM)	Extension (%)
[0 - 150 [	94	7556,951423	7445,170671	1,50%
[150 - 300 [	119	26626,35531	25816,61814	3,14%
[300 - 500 [	217	87917,84616	86083,40775	2,13%
[500 - 800 [	519	343160,0144	337790,0717	1,59%
[800 - 1200 [	743	739560,7007	721530,3668	2,50%
[1200 - more [	1010	2509754,602	2451027,978	2,40%
Total	2702	3714576,47	3629693,613	2,34%

Scenario

Distance Ranges (NM)	Number of flights	Route Distance (NM)	Direct Distance (NM)	Extension (%)
[0 - 150 [	94	7556,951423	7445,170671	1,50%
[150 - 300 [	119	26620,14531	25816,61814	3,11%
[300 - 500 [	216	87377,88148	85592,02678	2,09%
[500 - 800 [	520	343491,6675	338227,2423	1,56%
[800 - 1200 [	741	737207,822	720319,2289	2,34%
[1200 - more [	1010	2509329,317	2451026,108	2,38%
Total	2700	3711583,785	3628426,395	2,29%

Table 5: Route length comparison SC1 vs. SC2



Picture 4 : Delta trajectory SC1 – SC2

4.2. SC1 VS SC2: Delta sector load

Sector	SC1	SC2	Delta SC1 vs SC2
EPWWBH	406	394	-12
EPWWDWH	386	375	-11
EPWWTWH	368	361	-7
EPWWFH	206	204	-2
EPWWGH	238	237	-1
EPWWBL	301	300	-1
EPWWCL	398	397	-1
EPPOTAN	77	77	0
EPWAS	554	554	0
EPWAN	182	182	0
EPPOTAS	80	80	0
EPGDTA	119	119	0
EPLBTA	18	18	0
EPRZTA	22	22	0
EPBYCR	5	5	0
EPLLTA	11	11	0
EPKTCR	45	45	0
EPRATA	1	1	0
EPZGCR	1	1	0
EPLRAZ	1	1	0

Sector	SC1	SC2	Delta SC1 vs SC2
EPSCTA	14	14	0
EPLBCR	17	17	0
EPRZCR	20	20	0
EPWWFIS	44	44	0
EPWWFL	116	116	0
EPWWDL	361	361	0
EPKKTA	168	168	0
EPSYTA	3	3	0
EPWWTL	390	391	1
EPWWGL	251	252	1
EPWWCH	213	215	2
EPWWNL	213	216	3
EPWWEL	449	452	3
EPWWRL	392	396	4
EPWWDEH	165	172	7
EPWWEH	197	204	7
EPWWTEH	133	142	9
EPWWNH	170	179	9
EPWWJL	472	482	10
EPWWJH	400	421	21
EPWWRH	297	343	46

4.3. SC1 VS SC2: Scenario economy

(Distance, fuel, CO2, NOx)

Scenario Economy for ... (Potential gains/losses)					
Total impacted flights	Length (NM)	Time (min)	Fuel (kg)	CO2 (kg)	NOx (kg)
404	-857,110	-112,530	-6712,630	-21210,020	-102,225

Table 6: Scenario economy SC1 vs. SC2

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5. Conclusions and Recommendations

5.1. Conclusions

Based on the results of the study performed, following conclusions could be drawn: Estimated potential benefits for the airspace users in terms of NMs saved in planning phase, on average, is in the order of magnitude of 4.500 NMs saving per day. Aggregated on annual basis this represents potential saving of 1 650 000 NMs.

It could be also concluded that external projects outside of Warsaw FIR (examples of FRA Bratislava ACC and SEE FRA projects are available as indication) will affect the efficiency of the flights and have impact on the operations in Warsaw ACC.

Although not explicitly studied in the course of the study, implementation of this airspace improvement will offer users to plan closer to what they are flying in real operations in the ACCs concerned.

Comparative analysis of sector load show that specific sector will have different sector distribution based on the new FRA planned trajectories. Very limited number of ATC sector in Warsaw might experience bigger change in term of overall number of flights compared to other sector. This specific observation requires further evaluation on a limited scale – fine-tuning of the model and check if some of it is result from clip of sector corners of some of the changed trajectories.

5.2. Recommendations

Following the conclusions in the previous chapter, it is recommended to:

- Proceed with implementation of FRA implementation within Warsaw FIR as the aggregated annual benefits for the airspace users are significant but also for the Warsaw ACC as in many cases the users will file flight plans closer or better from what they are flying at present thus leading to improved predictability.
- Check in real-time simulation with OPS expertise involved, to implement some specific measures (if/as required), to assure proper sector presentation of the traffic.
- Consider further expansion of the Cross-border operations to maximize potential benefits for all partners across the network.

In that respect to plan next steps of POLFRA project (Phase 2) to:

- Expand cross-border FRA operations with Lithuania in the scope of the Baltic FAB but more over to expand cross-border FRA operations to include potentially Bratislava ACC, SEE FRA initiative, Ukraine ACCs but also other adjacent ACC and partners e.g. LFV Sweden and DFS Germany. Also keep the study open for further validation and fine-tuning if needed, at least till the project is implemented.

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ANNEX A. AGGREGATION - ESTIMATED POTENTIAL BENEFITS

For aggregation of potential benefits, simulated traffic from 01 JUL 2017 is used.

As traffic on 01 JUL 2017 was higher than average day in 2017, for estimation of the potential benefits, there is a need to multiply it with 0,766925638 coefficient to estimate average daily benefits in 2017. (Highlighted in orange - table below)

Aggregated benefits on annual basis are simple multiplication of 365 days with the average daily benefits. (Highlighted in yellow - table below)

POLFRA				
01-Jul-17				
0,766925638				
	HFE (Delta route length in NM saved)	Flight time (minutes)	Fuel consumptions (in tons)	CO_2 (tons)
Simulated Day Savings	5.909	809	36	112
Average Daily Saving	4.532	621	27	86
Aggregated Annual Saving	1.654.004	226.576	9.969	31.393

Table 7: POLFRA project - Estimated potential benefits

ANNEX B. ACRONYMS AND ABBREVIATIONS

ACC	Area Control Centre
AIP	Aeronautical Information Publication
AIRAC	Aeronautical Information Regulation and Control
ANSP	Airspace Navigation Service Provider
AoR	Area of Responsibility
ARR	Arrival
ATC	Air Traffic Control, Air Traffic Control Domain
CDR	Conditional Route
DEP	Departure
DES	Airspace Design
DFS	Deutsche Flugsicherung GmbH
EUROCONTROL	European Organisation for the Safety of Air Navigation
FAB	Functional Airspace Block
FIR	Flight Information Region
FL	Flight Level
FRA	Free Route Airspace
kg	kilogram
LFV	Luftfartsverket Sweden
LoA	Letter of Agreement
min	Minute/s
NEST	Network Strategic Tool
NM	Nautical Mile
NMD	Network Manager Directorate
NMOC	Network Manager Operations Centre
PANSA	Polish Air Navigation Services Agency
RAD	Route Availability Document
RNDSG	Route Network Development Sub-Group
SAAM	System for traffic Assignment and Analysis at Macroscopic level
SC	Scenario
SID	Standard Instrumental Departure
STAR	Standard Arrival Route
TMA	Terminal Control Area
UIR	Upper Flight Information region

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