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ANALYSIS OF GENERAL AVIATION DOMESTIC AIR TRAFFIC STRUCTURE IN CONTROLLED AIRSPACE OF POLAND WITH REFER TO SESAR 2020, PJ.06-02 PROJECT SOLUTION

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Abstract

Civil air traffic in Poland is organized in accordance with international regulations provided by International Civil Aviation Organization (ICAO). Flight operations are performed in controlled airspace (CAS) or uncontrolled airspace. The division contains different approach to flight planning (FP) and group specific types of airspace users (AUs) and aircrafts types. Typically, General Aviation (GA) operations are placed in uncontrolled airspace while airline operations in CAS. This practice results from air operations types and aircrafts flight performance. GA includes sport, school, private transport or business flights and therefore the uncontrolled airspace with its vertical border form the ground to FL 95 contains most of the GA operations. However, there is a part of GA operations performed in CAS according to Instrument Flight Rules (IFR). The aim of the work is to describe the structure of domestic GA operations in IFR flights in CAS of Poland. Using the archival air traffic data from previous five years (2012-2016) the defined subject was analysed. In the first part, the aircraft fleet is presented. It contains the description of aircrafts types with relation to route distances, number of flights, propulsion type and wake turbulence category (WTC). In the second part, the network of defined air traffic was shown. It contains data about departure and destinations airports, the airports loading, month statistic of flights and trend in traffic changes. The traffic data are obtained from Eurocontrol database Demand Data Repository (DDR2) and using the NEST Eurocontrol software. The article arose during author's traineeship in Eurocontrol within a framework of SESAR 2020 project, PJ.06-02 solution. Presented analyses are useful from the FP point of view since the PJ.06-02 solution refers to "Management of Performance Based Free Routing in lower Airspace" and need to consider the features of every airspace users.

Keywords: *general aviation, controlled air traffic, SESAR 2020, IFR flights, domestic flights in Poland*

1. Introduction

The General Aviation (GA) is defined as a civil aviation operations other than scheduled air services and non-scheduled air transport operations for remuneration or hire [2, 8]. GA includes business aviation (BA) which stands for companies and individuals using aircraft as tools in the conduct of their business [5]. The definition covers wide range of civil flight missions and various types of aircrafts. The flight missions of GA apply to sport, school, private transport and business flights. These may be performed in both uncontrolled airspace and controlled airspace (CAS). The airspace in Europe above FL 195 is class of C and below FL195, it may be a mixture of different airspace classes, which coexist [4]. The ICAO classification of airspace [6] defines class C within Instrument Flight Rules (IFR). Visual Flight Rules (VFR) flights may exist and within Air Traffic Control (ATC) is provided to separate IFR flights from other IFR and VFR, and the VFR flights are separated from IFR and receive information of other VFR flights. The Flight Information Region (FIR) of Poland has CAS, which is class of C and begins at FL 95 (with exception of controlled airports zones where CAS starts below FL 95). The CAS in Poland has pre-defined air traffic route network (ATS route network).

From the SESAR 2020 project demands it is essential to know the structure of traffic in CAS [9]. The solution PJ.06-02 refers to "Management of Performance Based Free Routing in lower Airspace" [10]. This means future implementation of Free Routing Airspace (FRA) instead of

ATS route network at low FLs. For airspace users (AUs) it may improve predictability, efficiency and flexibility of flight planning (FP). It is connected with changes in FP approach since in FRA pre-defined air routes do not exist so that AU defines the flight route segments using pre-defined waypoints. This allows to better optimization of flight routes and higher compatibility of FP with actual flights. However, the difficulties with accommodation to new environment may appear. In aviation, safety is the highest value. Therefore, every change is implemented iteratively with collaboration of all stakeholders to provide smooth implementation of new solutions. Considering the PJ.06-02 solution objectives, the AUs shall be supported in accommodation to FP in FRA. One of the ways is to elaboration of algorithms and tools dedicated to FP in FRA environment. Preparation this kind of algorithms requires to recognize the target group of users.

This work is focused on description the General Aviation airspace users who perform domestic IFR flights in CAS of Poland. This is a specific group of AUs, which performs mainly private transport and business flight operations using variety types of aircrafts. Basing on the Eurocontrol archive flights database Demand Data Repository [3] and using dedicated NEST Eurocontrol software (Fig. 1), the defined air traffic within previous five years (2012-2016) was analysed. The first part concerns the description of aircrafts types fleet with relation to route distances, number of flights, propulsion type and wake turbulence category (WTC). The second part shows network air traffic data about departure and destinations airports, the airports loading, month statistic of flights and trend of air traffic changes. Due to quantity of used acronyms, the additional paragraph with descriptions was added. The work provides current view on the defined part of air traffic, which supports the works on SESAR 2020, PJ.06-02 solution.

2. Demand Data Repository database description

Demand Data Repository (DDR2) database storages the archive air traffic and airspace structure in ECAC area [1, 3]. This is provided by EUROCONTROL Network Manager Directorate, Operations Planning Unit. The DDR2 is supported by SAAM and NEST Eurocontrol software, which are dedicated to design and analyse the air traffic and airspace structure.

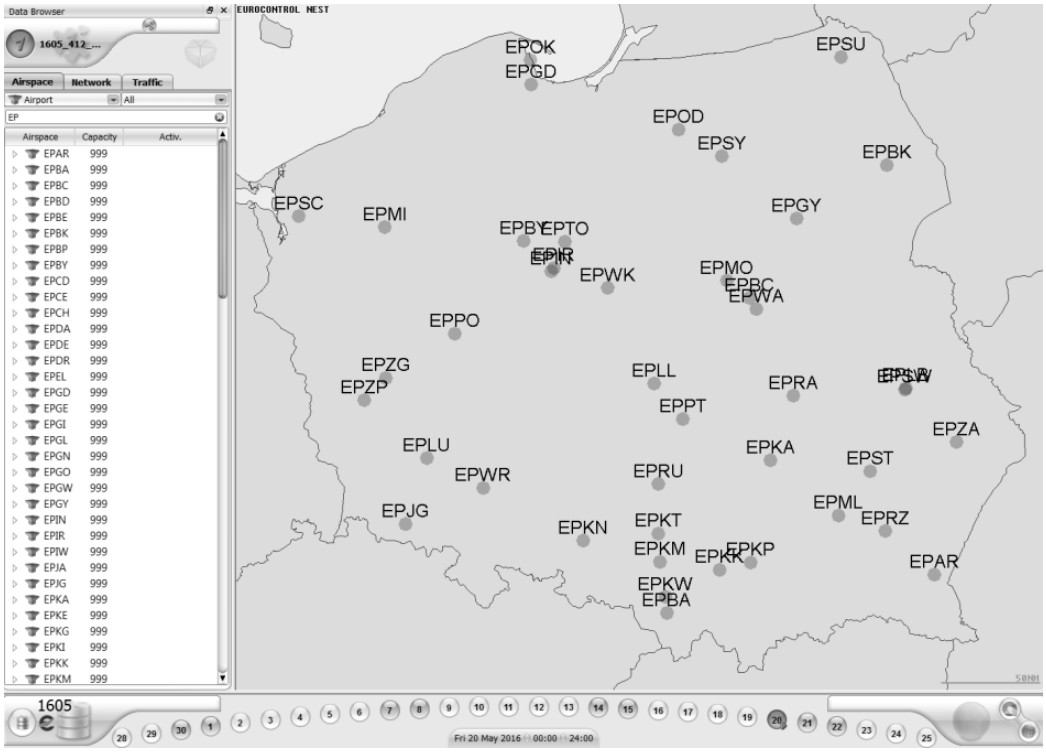


Fig. 1. NEST Eurocontrol software interface (airports location in analysed flights, Ch. 4) [3]

3. General Aviation fleet structure

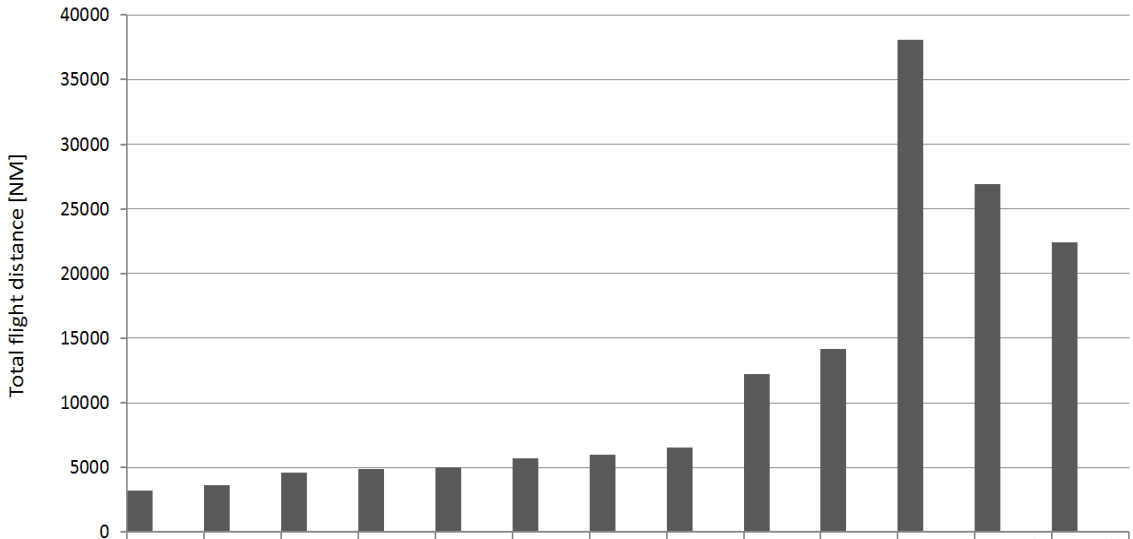
The GA fleet in IFR flights is used mainly for private transport or business activity. It consists of variety types of light, medium and large weight aircrafts. Tab. 1 presents all the types of aircrafts used for defined type of flight operations in the previous five years.

Tab. 1. Aircraft types used for GA IFR operations in CAS of Poland

ICAO aircraft type designator [7]	Aircraft name	Wake turbulence category	Engine type	Number of engines	ICAO aircraft type designator	Aircraft name	Wake turbulence category	Engine type	Number of engines
AEST	PA-60 Aerostar	L	Piston	2	G150	Gulfstream G150	M	Jet	2
AN24	Antonov An-24	M	Turboprop	2	G280	Gulfstream G280	M	Jet	2
AN26	Antonov An-26	M	Turboprop	2	GALX	Gulfstream G200	M	Jet	2
B350	Beechcraft King Air 350	L	Turboprop	2	GL5T	Bombardier Global 5000	M	Jet	2
B733	Boeing 737-300	M	Jet	2	GLEX	Bombardier Global Express	M	Jet	2
B737	Boeing 737-700	M	Jet	2	GLF3	Gulfstream 3	M	Jet	2
B738	Boeing 737-800	M	Jet	2	GLF4	Gulfstream 4	M	Jet	2
B752	Boeing 757-200	M	Jet	2	GLF5	Gulfstream 5	M	Jet	2
BE20	Beechcraft King Air 200	L	Turboprop	2	GLF6	Gulfstream G650	M	Jet	2
BE58	Beechcraft 58 Baron	L	Piston	2	H25B	Bae-125-700	M	Jet	2
BE9L	Beechcraft King Air 90	L	Turboprop	2	H60	CH-601 Zodiac	L	Piston	1
C182	Cessna C182	L	Piston	1	HA4T	Hawker Beechcraft 4000	M	Jet	2
C206	Cessna 206 Super Skywagon	L	Piston	1	HDJT	Honda HA-420 HondaJet	L	Jet	2
C210	Cessna 210 Centurion	L	Piston	1	L410	L-410 Turbolet	L	Turboprop	2
C25A	Cessna Citation CJ2	L	Jet	2	LJ45	Learjet 45	M	Jet	2
C25B	Cessna Citation CJ3	L	Jet	2	LJ60	Learjet 60	M	Jet	2
C414	Cessna 414 Chancellor	L	Piston	2	LJ75	Learjet 75	M	Jet	2
C421	Cessna 421 Ecxec. Commuter	L	Piston	2	M20T	Mooney Bravo	L	Piston	1
C425	Cessna 425 Corsair	L	Turboprop	2	M28	PZL-Mielec M-28	M	Turboprop	2
C441	Cessna 441 Conquest	L	Turboprop	2	P210	Cessna P210	L	Piston	1
C525	Cessna Citation CJ1	L	Jet	2	P46T	Piper Malibu	L	Turboprop	1
C550	Cessna Citation 2	L	Jet	2	PA31	Piper Navajo	L	Piston	2
C551	Cessna Citation 2 SP	L	Jet	2	PA32	Piper PA-32 Saratoga	L	Piston	1
C56X	Cessna 562XL Citation Excel	M	Jet	2	PA34	Piper PA-34 Seneca	L	Piston	2
C680	Cessna 680 Cit. Soveregin	M	Jet	2	PA46	Piper Pmalibu Mirage	L	Piston	1
CL30	Bombardier Challenger 300	M	Jet	2	PC12	Pilatus PC-12	L	Turboprop	1
CL60	Bombardier Challenger 650	M	Jet	2	PRM1	Beechcraft Premier 1	L	Jet	2
DA40	Diamond DA40	L	Piston	1	S22T	Cirrus SR 22 Turbo	L	Piston	1
DH8D	DHC-8-400 Dash 8	M	Turboprop	2	SIRA	Tecnam Sierra	L	Piston	1
E135	Embraer E135	M	Jet	2	SR20	Cirrus SR20	L	Piston	1
E190	Embraer E190	M	Jet	2	SR22	Cirrus SR22	L	Piston	1
E550	Embraer 500 Legacy	M	Jet	2	STAR	Beech Starship	L	Turboprop	2
E55P	Embraer Phenom 300	M	Jet	2	TB20	Socata TB20	L	Piston	1
EA50	Eclipse 500	L	Jet	2	TB21	Socata TB21 Trinidad	L	Piston	1
EC35	Eurocopter EC-135	H	Turboprop	2	TBM7	Socata TMB 700	L	Turboprop	1
F2TH	Dassault Falcon 2000	M	Jet	2	TBM8	Socata TBM-850	L	Turboprop	1
F900	Dassault Falcon 900	M	Jet	3	TOBA	Socata TB10 Tobago	L	Piston	1
FA50	Dassault Falcon 50	M	Jet	3	TRIN	Socata Trinidad	L	Piston	1
FA7X	Dassault Falcon 7X	M	Jet	3	W3	PZL Świdnik W3 Sokół	H	Turboprop	2

Total amount of used aircraft types is 78 and these are mainly light or medium weight aircrafts. However, there exists small part of large weight class aircrafts (Boeing 737 series). The propulsion type contribution is: 45% of twin jet engines, 22% of single piston engine, 16% of twin turboprop engines; 8% of twin piston engines; 5% of single turboprop engines and 4% of triple jet engines. The wake turbulence category is low (L) for 54% aircraft types, medium (M) for 44% aircraft types and helicopter category (H) for 2% aircraft types.

To complete the view of GA fleet the statistics of overall flight distance and number of flights with refer to aircraft types was prepared (Fig. 2).



	C414	GLF4	TB21	PRM1	DA40	P46T	GLEX	GLF5	SR22	EA50	PC12	Aircraft < 1% (59 types)	Aircraft < 2% (11 types)
Distance [NM]	3228,7	3623,4	4579,1	4884,2	5037,8	5671,5	6008,4	6511,5	12248,7	14173,6	38094,9	26932,6	22430,7
Distance contribution [%]	2,10	2,35	2,97	3,17	3,27	3,68	3,90	4,23	7,96	9,21	24,75	17,49	14,57
Number of flights	25	23	32	26	22	38	37	41	92	71	203	184	127

Fig. 2. Flight distance and number of flights in relation to aircrafts types

The used type of aircrafts and their contribution in total flight distance in last 5 years indicates that the majority of GA flights in CAS of Poland are business aviation operations. Types such as C414, EA50, GLEX, GLF4, GLF 5, PC12 and PRM 1 are aircrafts able to transport 6 or more passengers and their contribution in flight distance and number of flight operations is 48.5%. This contribution is higher after including similar types of aircrafts, which distance contribution, is less than 2%. Approximately the proportion between private transport and business flights is 27.2% and 72.8%. This proportion in short range may be different because it was built basing on aircrafts types and the DDR2 do not storage exact data of air operations types.

4. General Aviation network traffic structure

The chapter contains data about network of GA IFR flights in Poland. Tab. 2 present lists of airports used as origin and destination and together with Fig. 1, 3 provide the data of airport loading by defined air operations. The number of flights contribution with relation to months of a year is presented on Fig. 4. The trend of defined air traffic changes is shown on Fig. 5.

Total amount of 42 airports is used in defined GA operations where 13 of them are controlled airports. The highest airport loading concern controlled airports placed in the neighbourhood of main cities of Poland. The exception are EPLU, EPOD and EPKA uncontrolled airports which service important cities too. The majority of air operations are placed in Warsaw region (EPWA, EPMO and EPBC) which contain 36% of arrival/departure operations (Fig. 3).

Tab. 2. Airports used in analysed GA operations

ICAO Airport code	Airport name	Controlled [C] Uncontrolled [NC]	ICAO Airport code	Airport name	Controlled [C] Uncontrolled [NC]
EPAR	Arłamów	NC	EPML	Mielec	NC
EPBA	Bielsko – Biała Aleksandrowice	NC	EPMO	Modlin	C
EPBC	Warszawa – Babice	NC	EPOD	Olsztyn – Dajtki	NC
EPBK	Bialystok – Krywlany	NC	EPOK	Gdynia – Kosakowo	NC
EPBY	Bydgoszcz – Szwederowo	C	EPPO	Poznan – Ławica	C
EPGD	Gdansk – Rębiechowo	C	EPPT	Piotrków Trybunalski	NC
EPGY	Grądy	NC	EPRA	Radom – Sadków	NC
EPIN	Inowrocław	NC	EPRU	Czestochowa – Rudniki	NC
EPIR	Inowrocław – Latkowo	NC	EPRZ	Rzeszow – Jasionka	C
EPJG	Jelenia Góra	NC	EPSC	Szczecin – Goleniów	C
EPKA	Kielce – Masłów	NC	EPST	Stalowa Wola – Turbia	NC
EPKK	Krakow – Balice	C	EPSU	Suwałki	NC
EPKM	Katowice – Muchowiec	NC	EPSW	Świdnik	NC
EPKN	Kamień Śląski	NC	EPSY	Olsztyn – Mazury	NC
EPKP	Krakow – Pobiednik	NC	EPTO	Torun	NC
EPKT	Katowice – Pyrzowice	C	EPWA	Warszawa – Okęcie	C
EPKW	Kaniów	NC	EPWK	Włocławek – Kruszyn	NC
EPLB	Lublin	C	EPWR	Wroclaw – Strachowice	C
EPLL	Lodz – Lublinek	C	EPZA	Zamość – Mokre	NC
EPLU	Lubin	NC	EPZG	Zielona Góra – Babimost	C
EPMI	Mirosławiec	NC	EPZP	Zielona Góra – Przylep	NC

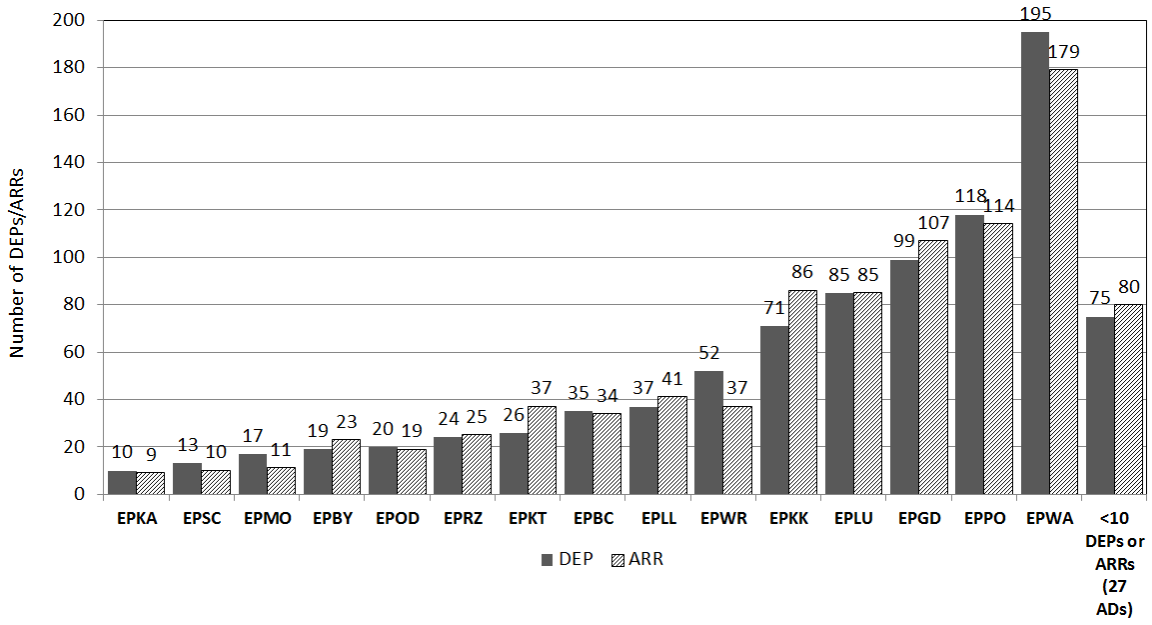


Fig. 3. Airport loading by departure (DEP) and arrival (ARR) operations

The structure of month traffic shows that before and shortly after the vacations (May, June, September, October) the number of flights is the highest. The probable cause is the intensification of business activities before the leave time. It corresponds with previous observation of proportion business to private air operations. There is no available data about air operations types. However, omitting the mentioned traffic peak the regular increase/decrease changes in traffic is correlated with year seasons and maximum occurs in summer months (Fig. 4).

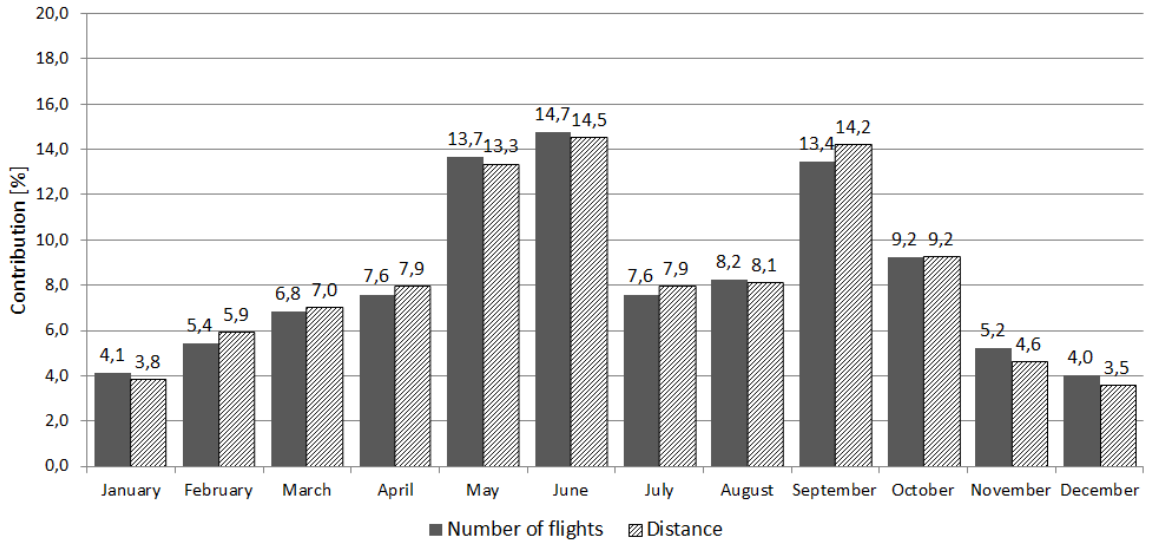


Fig. 4. GA IFR number of flights and distance contribution with correlation to months of a year

The researches have shown that description of traffic changes trend is not regular (Fig. 5). Defined GA traffic from previous 5 years is still too short period to indicate the general tendency. The highest number of flights is in 2012 and in the next years approximately remains on constant level.

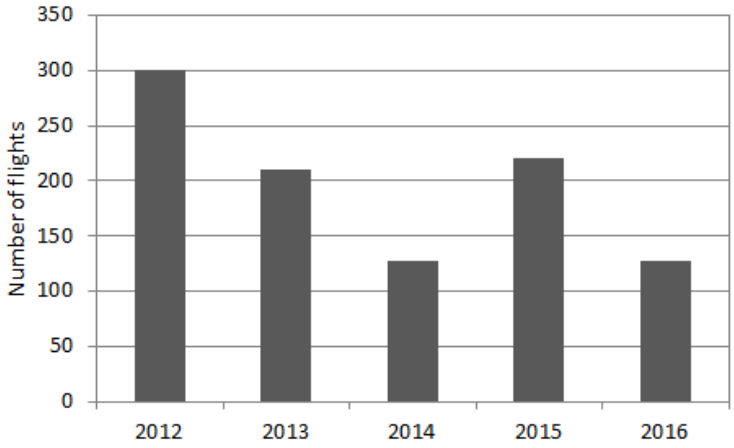


Fig. 5. Trend in yearly number of flights changes

5. Conclusions

Considering the SESAR, PJ.06-02 solution objectives, which concern the Management of Performance Based Free Routing in lower Airspace the analysis of GA IFR domestic flights in CAS of Poland, were presented. The work supports the initial design stage of algorithms for flight planning in FRA providing recommendations to algorithms possibilities.

The analysed type of air traffic and AUs indicates that the majority of flights are performed for business purposes with 72.8% contribution (Ch. 2). The aircraft fleet used in the business flights consist of twinjets (mainly), turboprops and twin pistons, which cruise airspeeds, remain relatively high. Air traffic connections are realized mostly between main cities of Poland where controlled airports are located. Considering above the FP algorithms should be able to perform both smooth connection between FRA and airports Terminal Manoeuvring Area (TMA) and accommodate non-scheduled flights with regular connections in FP optimization. Small aircrafts used in private

transport fly with low airspeed and connect both small regional airports and main controlled airports. Therefore, the methods of safe coexisting flights with different cruise speed have to be taken into consideration in FRA connections. Regarding the uncontrolled airports the departure/arriving operations requires smooth transition of flight route from uncontrolled airspace to user defined route segments in FRA. The airports location (Fig. 1, Tab. 2.) tend to form approximately straight lines within controlled airports are placed (for instance EPLL and EPBA form line within several airports exist, including EPKT controlled airport). In order to provide cost benefits and effective routes the methods of crossing the TMAs should be included in FP algorithms. The article provide initial view on characteristics and demands of specified AUs group in order to support the works on SESAR, PJ.06-02 solution in terms of FP algorithms. Further works shall remain in the topic of analysed AUs group and include analysis of wider range of air operations parameters and fleet performances.

6. Acronyms

The acronyms used in the article are compatible with air traffic management nomenclature. Description of used acronyms is listed below.

AD – Aerodrome
ATC – Air Traffic Control
ATM – Air Traffic Management
ATS route airspace – airspace within users plan their flights using pre-defined route segments
AU – Airspace User – organizations operating aircraft, and their pilots
BA – Business Aviation – one of the components of general aviation, consists of companies and individuals using aircraft as tools in the conduct of their business
CAS – Controlled Airspace – airspace type of defined dimensions within which air traffic control service is provided to IFR flights and to VFR flights in accordance with the airspace classification
DDR2 – Demand Data Repository
ECAC – European Civil Aviation Conference
FIR – Flight Information Region
FL – Flight Level
FP – Flight Plan, Flight Planning
FRA – Free Route Airspace – airspace within users plan the routes between defined waypoints without reference to the ATS route network
GA – General Aviation – all civil aviation operations other than scheduled air services
and non-scheduled air transport operations for remuneration or hire
ICAO – International Civil Aviation Organization
IFR – Instrument Flight Rules
NEST – Network Strategic Tool (Eurocontrol software)
SAAM – System for air traffic Assignment and Analysis at a Macroscopic level (Eurocontrol software)
SESAR – Single European Sky ATM Research
TMA – Terminal-Manoeuvring Area
Uncontrolled airspace – airspace type of Class G and specified Class F airspace within which ATC service is not provided
VFR – Visual Flight Rules
WTC – Wake Turbulence Category – turbulence that is generated by the passage of an aircraft through the air

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