CZECH TECHNICAL UNIVERSITY IN PRAGUE

FACULTY OF TRANSPORTATION SCIENCES

Marcela Růžičková

ANALYSIS OF THE INTEGRATED INITIAL FLIGHT PLAN PROCESSING SYSTEM ZONE EXTENSION

Master's thesis

2019

CZECH TECHNICAL UNIVERSITY IN PRAGUE
Faculty of Transportation Sciences
Dean's office
Konviktská 20, 110 00 Prague 1, Czech Republic

K621.....Department of Air Transport

MASTER'S THESIS ASSIGNMENT

(PROJECT, WORK OF ART)

Student's name and surname (including degrees):

Bc. Marcela Růžičková

Code of study programme code and study field of the student:

N 3710 – PL – Air Traffic Control and Management

Theme title (in Czech): **Analýza rozšíření Integrated Initial Flight Plan Processing System zóny**

Theme title (in English): Analysis of the Integrated Initial Flight Plan Processing Zone Extension

Guides for elaboration

During the elaboration of the master's thesis follow the outline below:

- History and general introduction to Integrated Initial Flight Plan Processing System
- Requirements for the entrance to the Integrated Initial Flight Plan Processing System zone
- Examples of members states - what has changed and how the system works
- Evaluation of the neighbouring states
- Conclusion and final map of states

Graphical work range: according to the master's thesis supervisor instructions

Accompanying report length: minimum of 55 pages (including pictures, graphs and tables which are included in the accomanying report)

Bibliography:
EUROCONTROL - IFPS Users Manual
FAA ICAO Flight Planning Interface Reference guide
EUROCONTROL - A Guide to the Network Manager Operations Centre (NMOC)

Master's thesis supervisor: **Ing. Michal Pazourek**
doc. Ing. Jakub Hospodka, Ph.D.

Date of master's thesis assignment: **July 28, 2017**
(date of the first assignment of this work, that has be minimum of 10 months before the deadline of the theses submission based on the standard duration of the study)

Date of master's thesis submission: **May 28, 2019**
a) date of first anticipated submission of the thesis based on the standard study duration and the recommended study time schedule
b) in case of postponing the submission of the thesis, next submission date results from the recommended time schedule

ČESKÉ VYSOKÉ UČENÍ TECHNICKÉ V PRAZE Fakulta dopravní -3-
L. S.

doc. Ing. Jakub Kraus, Ph.D.
head of the Department of Air Transport

doc. Ing. Pavel Hrubeš, Ph.D.
dean of the faculty

I confirm assumption of master's thesis assignment.

Bc. Marcela Růžičková
Student's name and signature

Prague .....December 3, 2018

ČESKÉ VYSOKÉ UČENÍ TECHNICKÉ V PRAZE
Fakulta dopravní
d ě k a n
Konviktská 20, 110 00 Praha 1

K621 ..... Ústav letecké dopravy

ZADÁNÍ DIPLOMOVÉ PRÁCE

(PROJEKTU, UMĚLECKÉHO DÍLA, UMĚLECKÉHO VÝKONU)

Jméno a příjmení studenta (včetně titulů):

Bc. Marcela Růžičková

Kód studijního programu a studijní obor studenta:

N 3710 – PL – Provoz a řízení letecké dopravy

Název tématu (česky): **Analýza rozšíření Integrated Initial Flight Plan Processing System zóny**

Název tématu (anglicky): Analysis of the Integrated Initial Flight Plan Processing Zone Extension

Zásady pro vypracování

Při zpracování diplomové práce se řiďte osnovou uvedenou v následujících bodech:

- Historie a obecný úvod do Integrated Initial Flight Plan Processing System
- Kritéria pro vstup do Integrated Initial Flight Plan Processing System zóny
- Příklady posledních vstupních států - změny a fungování systemu
- Ohodnocení sousedních států, které do Integrated Initial Flight Plan Processing System zóny nespadají, ale mohly by
- Nalezená řešení a konečná mapa států

Rozsah grafických prací: dle pokynů vedoucího diplomové práce

Rozsah průvodní zprávy: minimálně 55 stran textu (včetně obrázků, grafů a tabulek, které jsou součástí průvodní zprávy)

Seznam odborné literatury:
EUROCONTROL - IFPS Users Manual
FAA ICAO Flight Planning Interface Reference guide
EUROCONTROL - A Guide to the Network Manager Operations Centre (NMOC)

Vedoucí diplomové práce: **Ing. Michal Pazourek**
doc. Ing. Jakub Hospodka, Ph.D.

Datum zadání diplomové práce: **28. července 2017**
(datum prvního zadání této práce, které musí být nejpozději 10 měsíců před datem prvního předpokládaného odevzdání této práce vyplývajícího ze standardní doby studia)

Datum odevzdání diplomové práce: **28. května 2019**
a) datum prvního předpokládaného odevzdání práce vyplývající ze standardní doby studia a z doporučeného časového plánu studia
b) v případě odkladu odevzdání práce následující datum odevzdání práce vyplývající z doporučeného časového plánu studia

ČESKÉ VYSOKÉ UČENÍ TECHNICKÉ V PRAZE Fakulta dopravní L. S.

doc. Ing. Jakub Kraus, Ph.D.
vedoucí
Ústavu letecké dopravy

doc. Ing. Pavel Hrubeš, Ph.D.
děkan fakulty

Potvrzuji převzetí zadání diplomové práce.

Bc. Marcela Růžičková
jméno a podpis studenta

V Praze dne ..... 3. prosince 2018

Poděkování/Acknowledgement

Ráda bych poděkovala panu Ing. Michalu Pazourkovi za odborné vedení mé diplomové práce, cenné připomínky, poskytnuté materiály a hlavně množství času, které mi v průběhu psaní věnoval. Děkuji taktéž doc. Ing. Bc. Jakubu Hospodkovi PhD. za akademické konzultace a pomoc s formálními náležitostmi práce. Dále bych chtěla poděkovat panu Ing. Otovi Hajzlerovi za ochotu a poskytnuté informace z hlediska plánování letů.

I would also like to thank Mr Benoit Houot for his explanations and valuable inputs. My special thanks are extended to Özgür Ayhan and other European flight planners, whose remarks and information allowed me to conduct a comprehensive analysis.

Prohlášení

Prohlašuji, že jsem předloženou práci vypracovala samostatně a že jsem uvedla veškeré použité informační zdroje v souladu s Metodickým pokynem o dodržování etických principů při přípravě vysokoškolských závěrečných prací.

Nemám závažný důvod proti užívání tohoto školního díla ve smyslu § 60 Zákona č. 121/2000 Sb., o právu autorském, o právech souvisejících s právem autorským a o změně některých zákonů (autorský zákon).

V Praze dne: 27.5.2019

Marcela Růžičková …….

Marcela Růžičková

CZECH TECHNICAL UNIVERSITY IN PRAGUE

Faculty of Transportation Sciences

ANALYSIS OF THE INTEGRATED INITIAL FLIGHT PLAN PROCESSING SYSTEM ZONE EXTENSION

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ABSTRACT

This work is generally engaged with the European flight plan processing system. It briefly explains the history and development of air traffic control and describes the current framework and the importance of its structures. The prime part of the thesis is focused on the analysis of IFPS Zone extension; it lists the reasons, describes the transformation process, highlights the benefits and mentions possible challenges. Statements are supported with a detailed study of two non-European members, Morocco and Israel. As potential candidates, FIR Minsk and FIR Kaliningrad are discussed in terms of IFPZ entrance.

Keywords:

IFPS, Collaborative Flight Planning, IFPZ Extension, FIR Kaliningrad, FIR Minsk

ČESKÉ VYSOKÉ UČENÍ TECHNICKÉ V PRAZE

Fakulta dopravní

ANALÝZA ROZŠÍŘENÍ INTEGRATED INITIAL FLIGHT PLAN PROCESSING SYSTEM ZÓNY

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ABSTRAKT

Práce se zabývá evropským systémem pro zpracování letových plánů. Krátce vysvětluje historii a vývoj řízení letového provozu a popisuje současný systém a důležitost jeho struktury. Hlavní část textu je zaměřena na analýzu rozšíření IFPS zóny; obsahuje seznam požadavků, popisuje nutné změny a transformační proces, zdůrazňuje výhody a zabývá se i možnými nedostatky. Tvrzení jsou podpořena detailní studií dvou mimoevropských členských států, Maroka a Izraele. V rámci možného vstupu do IFPS zóny jsou jako potenciální kandidátské oblasti posouzeny FIR Minsk a FIR Kaliningrad.

Klíčová slova:

IFPS, Centralizované plánování letů, Rozšíření IFPS Zóny, FIR Kaliningrad, FIR Minsk

Table of Contents

1 Abbreviations

ACK	Acknowledgement Message
ADEXP	ATS Data Exchange Presentation
AFP	ATC Flight Plan Proposal
AFTN	Aeronautical Fixed Telecommunication Network
AIP	Aeronautical Information Publication
AIS	Aeronautical Information System
ARO	Air Traffic Service Reporting Office
ASBU	Aviation System Block Upgrades
ATCU	Air Traffic Control Units
ATFM	Air Traffic Flow Management
ATFCM	Air Traffic Flow and Capacity Management
CDM	Collaborative Decision Making
CFMU	Central Flow Management Unit
CRCO	Central Route Charges Office
CSO	CFMU System Operations
EACCC	European Aviation Crisis Coordination Cell
EAD	AIS Database
EC	European Commission
ECAC	European Civil Aviation Conference
ETFMS	Enhanced Tactical Flow Management System
EU ATM	Unified Air Traffic Management
FAB	Functional Airspace Block
FIR	Flight Information Region
FPL	Flight Plan
FRA	Free Route Airspace
ICAO	International Civil Aviation Organization
IFPS	Integrated Initial Flight Plan Processing System
IFPZ	IFPS Zone

MATMC	Main Air Traffic Management Center
NM	Network Manager
NMOC	Network Manager Operations Center
NOP	Network Operations Portal
NOTAM	Notice to Airmen
NSP	Network Strategy Plan
REJ	Rejection Message
RPL	Repetitive Flight Plan
SES	Single European Sky
SESAR	Single European Sky ATM Research
SSR	Secondary Surveillance Radar
STATFOR	Statistics and Forecast Service
WBT	Web-based training

2 Introduction

This Master's thesis is a follow-up to the Bachelor thesis written in 2016. The previous text was aimed on the problematics of global flight plan processing systems, their functioning and qualities, but mainly, differences and challenges. Potential solutions were briefly introduced to avoid frequent delays coming from these irregularities. This text expands one of the offered resolutions, the extension of a well-functioning European system, Initial Integrated Flight Plan Processing System (IFPS).

Since its start, at the beginning of the 20th century, air traffic has covered an enormous and incredible way. Slowly but continuously, it became an inherent form of transportation all over the world. In these days, safety, speed and efficiency are the main benefits of air transportation. However, to keep these values at their highest levels and to make the system work in the first place, many different technologies and people are needed. Flight planning and flight plan processing represent an important part of the whole framework. In a pilot's understanding, air traffic control works the same way all around the world. Operators fill in a flight plan according to the instructions prepared by their air traffic control corporate and if everything is compliant with the rules and regulations, the flight plan goes through. It is distributed to individual units on the way, and air traffic services are provided during the whole flight. The process, as described, may seem very easily. However, in fact, it is much more difficult. There are various schemes in different countries, and behind the scenes, many individual subsystems take care of the flight plan analysis and transformation into a form that is understandable and usable by everyone. It is an uneasy task, but so far, we have been capable of handling these differences successfully.

During the last years, European air traffic has become much busier, and the airspace is now full to overthrowing. Connectivity and globalization, growing tourism due to affordable flights and, therefore, increased demand, push the limits to incredible volumes. However, growing air traffic market is not the only reason; politics and following airspace limitations play their roles, too. For instance, the recent Pakistan-India issue from February 2019 resulted in the closure of Pakistani airspace, which was one of the main European routes to Southeast Asia. Out of a sudden, the overall capacity shrunk, and re-routing all affected flights to keep the traffic going and meet the demand was very challenging. Another example could be the embargo, that was put on Qatar from its neighbors United Arab Emirates, Saudi Arabia and Bahrain in 2017, due to which new alternative transport routes needed to be found. Economic reasons represent another important

driver in terms of choosing certain corridors. Regular operators optimize their routes considering not only the flight time, but also overall costs including overflight fees. It is no surprise, that cheaper countries tend to win, and therefore, these airspaces are fuller than others. As we discovered in the past, cooperation and centralized system is the key for handling such challenges. For European air traffic, it is the responsibility of EUROCONTROL to react to the increased air traffic volumes, and to take action while considering safety, performance/cost efficiency, capacity and environmentally-friendly solutions. Single European Sky and connected Single European Sky Air Traffic Management Research are initiatives investigated in the past, set in the present and being developed even for the future. Functional Airspace Blocks organizing airspace depending on the traffic rather than countries' borders, horizontal airspace division or Free Route Airspace are some of the concepts within these initiatives. In some parts of the world, mentioned solutions are perfect; for others, the implementation has not been possible due to operational reasons such as infrastructure, traffic volumes or Flight Information Regions' (FIR) shapes, and so, other ways are analyzed in the cooperation with neighboring airspace. As a well-functioning system, EUROCONTROL Network Manager has a potential to expand and include surrounding states to its structures. A constant pressure is put on the states on borders to join the organization or start collaboration at a higher level.

The purpose of this thesis is to analyze IFPS Zone (IFPZ) and its expansion into a well-functioning centralized flight planning system, spread beyond the borders of Europe. In the first part of the text, historical background is discussed as a necessary source for apprehension of the air traffic control development and, also, the need of EUROCONTROL Network Manager. Following is the current system overview and a brief description of how IFPZ works. Essential part of this chapter comprises of general reasons for IFPZ extension, its advantages and disadvantages, and, also, the list of entrance requirements. Statements are supported by looking at two member-countries, Morocco and Israel. These are analyzed using data from the past and current statistics to show, what has changed and which improvements the IFPZ entrance brought. Last chapter introduces two potential candidates and describes the transformation process, possible challenges and expected transition benefits. Chosen were two neighboring FIRs – FIR Minsk and FIR Kaliningrad. The analysis includes general description of the areas and current air traffic situation with future forecasts. Following is the entrance analysis regarding operational and technical points, estimated transition phase and prospective costs. Highlighted are benefits of the membership as well as reasons for countries to hold back in this manner.

This text should serve as a supportive document for states considering IFPZ entrance. It discusses the list of requirements and necessary changes as well as the benefits and challenges of the transition. The analysis and conclusions were made with the help of flight planning departments from different IFPZ countries, and, also with the support from EUROCONTROL.

3 System Overview

The introductory chapter briefly covers the history of air traffic control, beginnings of system integration in Europe and the current scheme overview. Emphasized is the development of EUROCONTROL Network Manager (NM).

3.1 History of Air Traffic Control

In order to understand the importance of flight planning and flight plan processing in the context of air traffic control, it is necessary to look at the history. A few next paragraphs serve as a quick summary of events and innovations, that occurred in the past – from the use of flags to current satellites systems. The whole history of air traffic and air traffic control worldwide is further discussed in the Bachelors' thesis. [1] For the purposes of this text, only certain facts were chosen with the focus on the European history.

3.1.1. Early Beginnings of Air Traffic

When the air traffic was at its beginnings, there was no need for airspace organization. Wright Brothers were the only people on the sky, they did not need any flight plan, they did not wait for any permission to take off or land and they did not have to report any changes in their intentions. At the beginning, the traffic flow density was very low, therefore, the pilot was the only one responsible for the safety of his/her aircraft. Pilots avoided other planes or obstacles using their sight.

The air traffic, as we know it today, began with the airmail service in 1911 in the United States. The first planned air route was established between St. Petersburg and Tampa Florida in 1914. Europe was not staying behind and, in 1910, there was the first European Air Law Conference. First airlines appeared and with the competition spirit, the development was becoming faster and faster. For the first time in the history, there was a need for air traffic control. In 1919, 27 states signed the first Convention on Safety Air Navigation and the International Commission for Air Navigation (ICAN) was founded.

3.1.2 The idea of ATC

With the increase of air traffic, pilot was no longer capable of taking care of everything. The need for another medium, that would support pilots and help them to fly safely, appeared. The idea of air traffic control came.

Before the First World War, ground personnel were gathering information and distributed these to the pilots prior to the flight. Air traffic control meant technical support for the pilots before take-off. At the airports, a so-called starter directed planes; outside of the airport, pilots were still responsible for the air traffic by using “See & Be Seen” procedure.

After the First World War, numbers of airspace users grew even more. First commercial airline companies, military aviation, airmail service and national organizations – they all needed to have the knowledge of the aircraft location in case something went wrong, so they could react and do something. There was also a need to keep the aircraft apart as it was difficult for a pilot to concentrate on flying the plane and controlling the background at the same time. Lots of commercial flights were flying the same routes in opposite directions, so the knowledge of the aircraft’s location was needed. Although, these flights were still conducted in low levels, and so visual navigation could still be used.

Throughout the time, radio network was implemented to the air transport technology with the first code, Q-Code. Q-Code was conveniently also used for localizing. The first concept of air traffic control at Croydon Airport London with G.J.H. Jeffs constant position calculation and distribution of navigational data, could be seen. Radio network and its workers were the first air traffic controllers. Shortly after that, on-board compasses started to be built in the aircraft.

3.1.3 ATC Development till Today

An enormous development in the field of ATC came with the Second World War. With fast technical progress and more aircraft being built, the sky was filled with flying machines. A more precise radio navigation needed to be developed.

After the Second World War, a few new things appeared on the scene such as RADAR, ILS, VOR and VOR/DME. All these innovations enabled airspace to be more precise and so the density

could grow, and separations could be smaller. When the 1950s' Jet era came, ATC had to respond. Secondary Surveillance Radar was established, and it has been used till this day.

ATC belongs to the world's youngest professions and as it is with other jobs, at the beginning, it was very trivial. During the time it has developed into a well-working and technologically perfect position. Air traffic control was trying to catch up with the innovations presented in the aircraft industry throughout the history, but in the early days, the air life was always a bit ahead of the ones on the ground. Different types of air traffic control were developed in different parts of the world. Basic things were the same, but in every time zone, sometimes even within the same country, certain diversity could be seen. Individual countries had access to dissimilar levels of technological innovations – especially during the Second World War. Other countries were using simple things, because these were the only tools, they had. Described separate structures were not necessarily compatible with each other and, therefore, communication between these systems and overall management in order to ensure proper working and safety in the sky was a very long and tedious task.

3.2 European Integration

3.2.1 Before EUROCONTROL

"Technical developments and increasing size of the air traffic brings along a growing demand for airspace capacities, ATC support, and especially cooperation and coordination of these services not only within Europe." [1] It all starts in 1919, when, after the First World War, international cooperation broadened with signing the first Convention on the safety of air navigation. This document brought up a few significant principles mentioned later in the Chicago agreement, while establishing ICAO in 1944, and, also, in the 1960 Convention that brought EUROCONTROL into life. [2].

On the 7th of December 1944, 52 states signed the Convention on International Civil Aviation. This document covered sovereignty of national airspace, standardization and general cooperation in aviation. Firstly, a Provisional International Civil Aviation Organization (PICAO) was established, because of the pending ratification by 26 states. At the beginning of March 1947, all pending 26 states ratified the Convention and International Civil Aviation Organization (ICAO) could officially start on 4th of April 1947.

From the beginning, the purpose of ICAO was promotion of safe and secure civil aviation. ICAO supported its member states in the improvement of civil aviation via projects of ICAO's Technical Cooperation Program. This program advices and assists members and funding entities in several matters, leading towards safe and efficient civil aviation. Even today, the Technical Cooperation Program belongs to the main ICAO activities and helps its members with the implementation of ICAO regulations, policies and procedures. [3]

In 1955, European Civil Aviation Conference (ECAC) was created with the aim of ensuring a safe and effective air traffic control system in Europe. However, the real motivation for establishment of an organization responsible for coordination and regulation of the European airspace came with the beginning of jet era in the late 1950s. EUROCONTROL came into the scene.

3.2.2. EUROCONTROL

As mentioned before, the start of EUROCONTROL leads back to 1919 and the first Convention on the safety of air navigation. Firstly, it was a technical working group of 7 European states that wanted to discuss important points of European aviation development and potential issues that can occur. Belgium, France, Italy, Luxembourg, the Netherlands, the Federal Republic of Germany and the United Kingdom were at the beginning of EUROCONTROL in 1958, however, the act establishing this organization in 1960 was only signed by six of these countries; Italy did not join. *"EUROCONTROL was the first institution that started to integrate individual European states in the area of air traffic."* [1] Its goals included creation of responses to the quickly growing air traffic development. The broad history of EUROCONTROL during 1960s and 1970s is further discussed in the text of the Bachelors' thesis. [1] The most important dates are listed in Table 1.

3.2.3 The beginnings of the centralized system (NMOC)

During the 1980s, air traffic in Europe increased and that resulted in delays. The air traffic control was not able to handle the amount of traffic in peak times and that created bottlenecks throughout the rest of the days and, also, in different areas in Europe. According to EUROCONTROL's

Table 1: EUROCONTROL History Dates (1960-1979)

EUROCONTROL HISTORY DATES (1960-1979)	
YEAR	**EVENT**
1963	Air Navigation (EUROCONTROL) Act
1969	IANS opened for personnel training
1971	CRCO established
1972	UAC Maastricht
1974	UAC Shannon
1977	UAC Karlsruhe

statistics: "*In 1986, 12% of flights were delayed for more than fifteen minutes on average. In 1989, 25% of all flights were delayed for more than 15 minutes."* [4] Due to these situations, even more delays came, and they lasted for longer periods. People were waiting at the airports for hours, sometimes overnight. ATM workers faced a huge pressure; there was a tremendous disruption in their work and they did not trust ATFM anymore. Something needed to be changed. This was the time when European ATM looked back at ICAO and used their concept of a centralized traffic management organization. Flow management positions were created in various states to regulate air traffic and balance available capacity with operating flights. However, the main actors soon realized, that ATFM at regional levels causes more problems. As every country protected their own airspace, individual authorities did not realize what is the impact of their actions towards the rest of the system. Skies were getting more and more limited and even more delays occurred. There was a need for a centralized system. In October 1988, transport ministers of all 23 ECAC member states gathered and decided on the implementation of the centralized concept. Central Flow Management Unit (CFMU) was established with EUROCONTROL on the top. 9 months later, EUROCONTROL set up a working team and building up of the whole system could begin. It all started with the pre-tactical phase and transforming many individual messages from several different FMUs into one single daily ATFM notification. At that time, computer systems started playing an important role in processing flights. The system of slot allocation appeared on the scene and there was also the idea of sending all FPLs to a single system. This was the start of IFPS. In 1994, first flight plans were collected by IFPS, which set one of the milestones for a future tactical AFTM. The initial idea was to have a simple system, that was going to aim for more consistent

and accurate information, and with its help the capacity was going to be used better while maintaining safety. The same year, CFMU also moved to Haaren, Brussels.

In April 1995, initial tactical operations started. Flights over air traffic management units in France and Switzerland, two bodies that stayed in Europe while CFMU was being built, now moved to Brussels. By November 1995, CFMU managed air traffic flow in 25 European states, and, also, Frankfurt FMU was moved to Haaren. Tens of air traffic controllers were taking care of their corresponding air traffic flows with CFMU. Early in the 1996, the UK, Rome and Spain and Portugal FMUs join the centralized system and that represented the final step for the transition. Air traffic flow in all 33 ECAC states was managed by CFMU. In March of the same year, IFPS was in its full operation; all flight plans were sent there. In the early years, CFMU's IFPS was processing and distributing more than 30 000 flights per day. Most of the flight plans were processed automatically, but there was still about fifteen per cent FPL messages every day with the need of manual change. These changes differed from minor interventions to more challenging alternative routes research.

After the establishment of CFMU, new technology started to arise. Between 1995 and 2000, we could follow a classical way of air traffic management. The system looked at the network, searching for potential problems, and if one of them was identified, a simple slot allocation solved the issue. In other words, flights were rather delayed right on the ground. This approach, however, was also generating lots of delays and, so, another solution needed to come to place. Directors and managers got together and decided to look at the problem from the other side. Instead of focusing on the delay solution, they decided to focus on the roots of the problem and extend capacities. This time, ATFM becomes ATFCM. The main concept meant following: before handling delays, firstly talk to different organizations and search for possible solutions – that way, the amount of delays that would need to be handled later, is minimized or even disappears. They asked air traffic centers to think about how their airspace could be used more efficiently in order to handle the peak traffic. They also spoke to military with regards to giving them a bigger flexibility in terms of planning their operations and, also, contacted airlines, if they were willing to re-route some of their flights in order to avoid busy areas. At the beginning, the average flight delays were close to 5 or 6 minutes and 20% of flights were delayed half an hour and more. With the support of CFMU, these delays started declining although the amount of traffic grew. The growth was close to 10% between 1999 and 2004, but delays were only 60% of the original issue. In 2004, the average flight delay decreased to 2 minutes, which was the goal set by the Provisional Council earlier. [5]

3.2.4 CFMU – good old things and new technology

While developing CFMU, couple of new systems were created on demand to meet the needs of CFMU (TACT, IFPS) while some were taken from the past (ENV, STRAT). During 1999 and 2001, system development went hand in hand with the new operational concepts such as FUA in 1997, What-If Reroute from 1998, 8.33 kHz spacing 1999 and RVSM 2000. New systems that appeared were IFPUV (1999), first web app (1999), Route catalogue system (2000) and PREDICT 2001.

In 2001, radar (CPR) ad meteorological data came into place. They brought more precise trajectories and significant delay reduction due to better use of capacity. In 2008, the first version of Network Operations Portal (NOP) was introduced and started the machine-human interface. Year 2009 brought the first b2b web services for direct systems and direct operations. Between 2010 and 2013 new concepts were integrated to the current IT systems. These were ASM-ATFCM, FRA, ICAO 2012 flight plan, A-CDM, DDR, CSST and usage of information from FAA. Since 2012, the development of SESAR's validation program and flight efficiency program has been supported to enable airlines to save and benefit from the whole system. Figure 1 shows the Evolutions of technical systems.

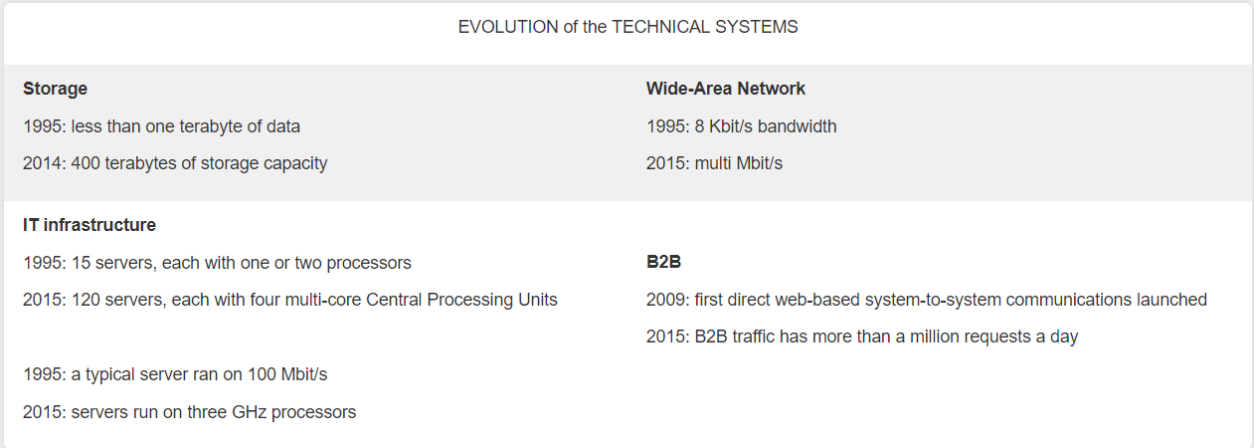

Figure 1: Evolution of the Technical Systems [4]

3.2.5 Building the trust

CFMU was built on strong foundations, coordinated by ICAO, national authorities, service providers and aircraft operators. All these actors cooperated in order to develop the system and

define its functions and activities. That created important bonds and confidence was gained between all aviation players.

To ensure a qualitive and safe system, CFMU was getting their accurate, current and reliable data from the airspace data management. Throughout the time, the goal became to run pre-validation and pre-implementation exercise. All development goals were met while keeping the pace of inputs. Thanks to these improvements, the role of CFMU was supported as a valuable tool for member states creating an efficient relationship when helping to quickly solve problems. Early, in 2002, the first Web-based training started in CFMU to ensure skilled and educated staff all around the operational area. CFMU System Operations supervised the whole system constantly. Ten years from the starting point, CFMU had developed far beyond its initial concept.

Central Flow Management Unit also played a huge role in the significant crisis from the past as a perfect and unique tool. Kosovo conflict in 1999 or the attacks of September 2001; the impacts of these events were minimized due to European ATFCM. In 2001, ATFCM action plan was implemented by establishing ETFMS which used radar data and brought better accuracy, better ATFM, better flow view. One example for all, in April 2010, a volcano in Iceland erupted. This event caused the cancellation of more than 100 000 flights effecting 1.2 million customers at 313 airports daily. According the IATA statistics, airlines lost was around 1.7 billion American dollars. The crises created a challenge for air traffic control as it was still necessary to meet the demand quickly, safely and efficiently. CFMU managed to get the situation under control and with previously scheduled flights, that eventually took place, handled hundreds of additional flights that were put in place for several reasons. Air traffic did not stop even in the main period of the crisis. Figure 2 shows the number of flights before and after the crisis. Immediately after the event, EUROCONTROL started with the analysis and tried to learn new lessons on how to handle similar situations in the future. *"Following the volcanic ash cloud crisis, the European Commission, EUROCONTROL and the European Aviation Safety Agency (EASA) created the European Aviation Crisis Coordination Cell (EACCC) on 21st May 2010, enabling Member States to coordinate their responses in the event of any future pan-European crisis severely affecting aviation."* [6] EACCC was fully supported and since that time, risk assessments and regular exercise are being executed to handle any future crisis.

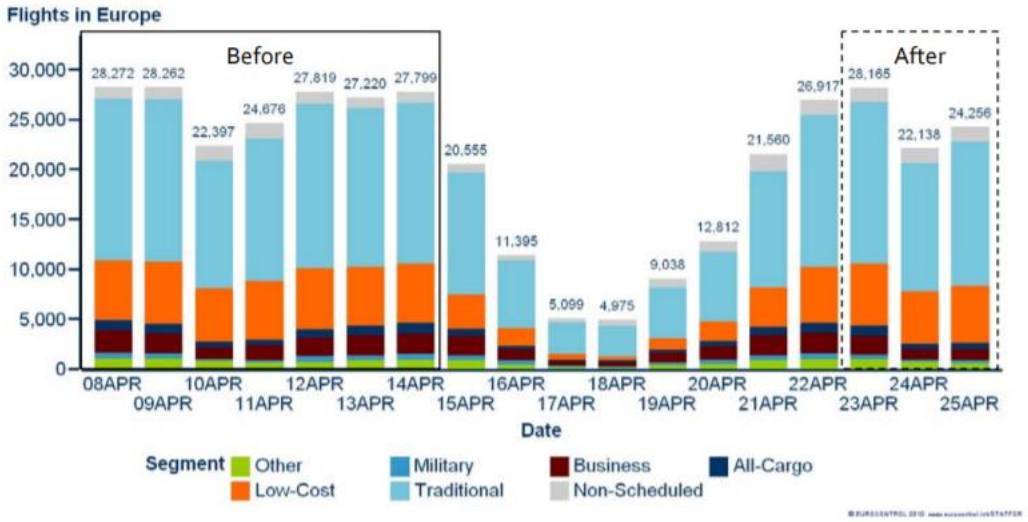

Figure 2: Traffic in Europe Before and After the April Crisis [6]

3.2.6 CFMU becomes NMOC

In 2011, the former label CFMU was replaced by Network Manager Operations Center (NMOC). The name transformation is connected to European Commission (EC) naming EUROCONTROL as a European Network manager. EC implemented rules and procedures leading to the improvement of the European air traffic management network and established EUROCONTROL NM as a single entity responsible for the European network management in 41 states (not all of them were part of the European Union) connected to a long-term initiative of Single European Sky (SES). A Network Strategy Plan (NSP) with huge number of targets was created, that were to make a significant contribution and move towards meeting the general safety and cost-efficiency goals. Undoubtedly, to achieve these goals, collaboration was always needed between various air traffic control actors. All these rules and procedures represent the summary of previously created assets that came into existence throughout the time with the help of everyone included in the process. This cooperation should be nurtured and kept for the future years.

3.2.7 From the Past till Today

Last twenty-five years were linked with constantly developing air traffic, increasing the number of tasks that air traffic control management needs to deals with. CFMU, and later NMOC, was

created as a response to the continuous delays that occurred in Europe during the 1980s. With the help of ICAO's ATFM and, also, ECAC states, NMOC took the situation under control while adopting effective operational procedures between all aviation players. Today, with the support of EUROCONTROL, NMOC continues in the development of extraordinary systems on the technical level, that is able to handle this enormously wide information domain.

In terms of air traffic control and management, after the establishment of NMOC (former CFMU), there have been no major failures. It is an efficient and well-maintained system, where every component has a back-up plan and one system supports the other. Throughout the time, air traffic and management activities created a dynamic environment in which strong management of airspace and conducted flights is needed. Other services needed to be added to the core activities, to ensure the efficiency and sustainability. Due to the need of a flight planning system, IFPS was established as an actor controlling flight plans under EUROCONTROL Network Manager. Consistent flight plan data and therefore an easy and convenient access to more information were the main drivers for such an action. The NMOC and IFPS, as we know them today, work since November 2004, when a full contingency center at Bretigny sur Orge was opened to support the main center in Brussels. [7]

Network manager works with an enormous amount of data, both static and dynamic. The messages are gathered from the air and from the ground. Aircraft's positions are updated every 30 seconds. It is a serious and technologically difficult task. According to EUROCONTROL: "*Just keeping track of aircraft in the air is a major challenge: in 1995, the daily average traffic was 15,890 flights. In 2008, the average number of flights reached 27,818 per day. In 2014, there were 26,685 aircraft accessing Europe's airspace every day."* [4]

3.3 EUROCONTROL and its Structures

Today, EUROCONTROL plays a central role in European Aviation. With the use of its systems and services and with the help of other European organizations, the organization creates a huge support tool for air traffic management around Europe and even beyond its borders.

In 2019, EUROCONTROL has 41 member-states. The list of the states and the years of their affiliation can be seen in Figure 3. Furthermore, EUROCONTROL has several agreements with

non-member states regarding the operations management. These arrangements are discussed in chapter 3.3.7.

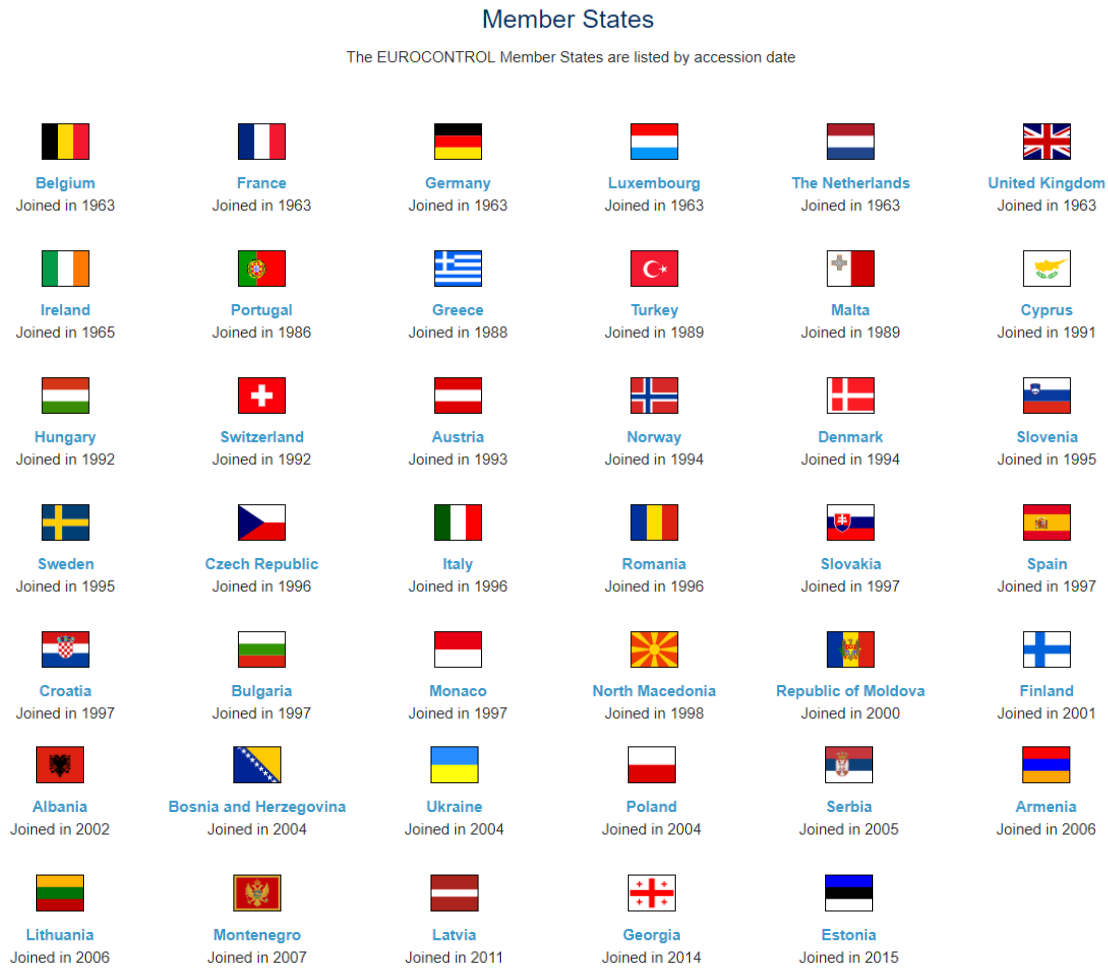

Figure 3: EUROCONTROL's Member States [9]

3.3.1 Network Manager

In short, EUROCONTROL Network Manager is one single flow management system across Europe. It covers in total 41 states, 1750 sectors (65 en-route centers), 520 airports, 1940 aircraft operators and 61 FMPs. This helps over 6700 users to deal with 36000 flights a day and 11 million flights per year. [8]

As stated in chapter 3.2.6, the Network Manager exists since 2011. "*The ATM Network Manager is a function which has been created by the European Commission to optimize the performance of the aviation network in Europe.*" [10] Thanks to the NM, various ATMs and aviation actors are brought together to ensure efficient and safe air traffic flow. NM also takes care of the former functions of CFMU.

The NMOC has two operational units – Haaren in Brussels and Bretigny sur Orge, close to Paris. It covers several fields, such as flow and capacity management, operations connected to flight planning, sharing information management as well as contingency and crisis management. Moreover, because NMOC represents a complex system, it also includes post-operational analysis and creation of reports that are constantly used to improve the system. All these services are lined with the SES Regulations.

NMOC is trying to bring together everyone involved in the process and make effective steps using Collaborative Decision Making (CDM). Flow management balances the available capacity of European airspace and the amount of flights operating in these areas. ATFCM also predicts air traffic situation and must be able to quickly and effectively react to any sudden events that can occur. A central database of airspace data maintained by NM, creates a basement for safe and efficient air traffic management. Excellent flight planning and flight plan processing service fills the whole system with valuable information and increases its effectivity. In EUROCONTROL NM's operational area, IFPS is responsible for collection, processing and distribution of flight plans. NMOC uses all accessible data and with the help of its tools and additional systems manages the air traffic flow within the EUROCONTROL members-states and other EUROCONTROL NM cooperating states.

3.3.2 Collaborative Decision Making and A-CDM

Collaborative Decision Making, according to EUROCONTROL ATM Lexicon is a *"A process focused on how to decide on a course of action articulated between two or more community members."* [11] CDM is a process, where inputs of all air traffic management actors are shared and combined, and the best objective decision is made. Airlines, air navigation service providers, airports and military authorities; all these represent slightly different interests, which are put into perspective when the new action results are considered. It is well known, that decisions of individuals differ from those that are made by groups. The general goal of this approach is to

improve the performance of the whole system considering and balancing individual air traffic management stakeholders' needs.

Airport CDM (A-CDM) is also a concept with a goal of improving ATFCM. In this process, airports' ATFCM-related decisions are dependable on the cooperation between all actors of the system community. It focuses on delays reduction, better predictability of events and, also, optimization of the resources use. A result of an effective A-CDM can be for instance flight updates collaborative management or variable taxi times. [12]

3.3.3 ATFCM

Air traffic flow and capacity management has the aim of optimizing air traffic flow while maintaining the safety by controlling airspace capacity. The planning starts early and is based on the estimated air traffic and, also, on the capacities issued by the air traffic control centers and airports. ATFCM also covers scenarios for specific events, mostly peaks due to holiday seasons or sporting events, where congestions and bottlenecks are expected. At the same time, it is responsible for creating a quick and organized response to any unplanned traffic events. The activities of ATFCM are divided into three phases – strategic, pre-tactical and tactical. Table 2 lists individual phases; states information about their duration, where they can be found and what is happening during their time.

Moreover, NMOC also offers the phase of deep analysis, in which everything that happened is broken down and conclusions are made about what is efficient and what is not, where the weak points and blind spots are, and what could be improved. Using all past data, forecasts are set for the future demand and potential issues.

Considering all these tasks, there is no doubt, that the more information NMOC has, the more efficient it can be in planning for operations on daily basis. Moreover, with better and more precise inputs, it can provide quicker, safer and more effective responses to previously unplanned events.

Table 2: ATFCM Activities [13]

ATFCM PHASES			
PHASE	**DURATION**	**PUBLISHED IN**	**DESCRIPTION**
Strategic	from 1 year before till 1 week before	Network Operations plan (NOP)	Support with capacity predictions for each of the ATC centers, preparation of routing scheme
Pre-tactical	6 days before	NOP portal	Coordination of daily plan aimed at optimized ATM network performance considering possible delays and necessary costs after CDM
Tactical	the day of operations	NOP portal	Monitoring and update of the daily plan, capacity optimization based on the real time traffic, offer of alternative solutions, flow management service

3.3.4 EAD

The European Aeronautical Information System (AIS) Database (EAD) is a service provided by EUROCONTROL. It includes a few integrated sub-systems that help any ATS unit to manage and organize their daily operations. EAD includes static data, for instance ATC airspace boundaries or possible routes, and dynamic data represented by current capacities or restrictions due to various reasons. Static data are also used for creation of other documents, such as Aeronautical Information Publication (AIP) or Chart Production. Another EAD's role is the distribution of Notice to Airmen (NOTAM) via International NOTAM Operations. At the same time, thanks to EAD, all users have access to these pieces of information. In the words of EUROCONTROL: *"Aeronautical information providers – such as AIS organizations from civil aviation authorities and air navigation*

service providers – enter and maintain their data in a central repository. In parallel, EAD enables data users – such as aircraft operators and private pilots – to retrieve and download AIS data from the system in real-time." [14]

EAD has 24/7 accessibility. Its data represent a reliable source, because it is controlled on a regular basis. The inputs come from EUROCONTROL and its clients, and everything is examined and compared with international regulations and new publications, ICAO standards and recommendations. This multiple-phasic process ensures the correctness, timeliness and complexity of the information. EAD does not provide only new and timely information, but also offers its members support in terms of an exchange forum. New ideas, different approaches and various experiences can be discussed to get the complex picture and make the best use of all accessible data.

3.3.5 IFPS

According to the EUROCONTROL ATM Lexicon, IFPS is "*A system of the Network Manager Operations Centre (NMOC) designed to rationalize the reception, initial processing and distribution of flight plan data related to IFR flight within the area covered by the participating States."* [15] In other words, IFPS is a centralized system responsible for collection, validation, processing and distribution of the FPLs for flights that are operated within or over the region called the IFPS Zone. IFPS brings all FPLs together into one repository to ensure, that aircraft operators, airports and air traffic control centers, as well as NMOC itself, all work with the same data.

IFPS and IFPZ are further discussed in chapter 4.

3.3.6 CRCO

Last tool within the EUROCONTROL NM, that is necessary to mention for the purposes of this thesis, is the Central Route Charges Office (CRCO). CRCO is a centralized system for collecting route fees offered by EUROCONTROL, but not limited to member states only. Its office is located at the headquarters in Brussels. In 1970, 7 members states agreed on a joint system for route charging via EUROCONTROL and CRCO was established in 1971. Member-states also agreed on the possibility of non-member states joining CRCO and many bilateral agreements were

signed. Since April 2017, the system is used by 40 states. [16] Apart from Ukraine, which is technically not integrated yet, CRCO is used by all EUROCONTROL member-states.

CRCO takes care of the fees related to the utilization of the controlled airspace managed by the EUROCONTROL operations area. On behalf of the member states, it calculates the route fees and charges any airspace users who use the air traffic services while flying within the area. CRCO also distributes fees information to the states concerned. As mentioned above, CRCO is a system provided by EUROCONTROL, but not restricted for EUROCONTROL's member states. Even though the main goal is to integrate the whole system, EUROCONTROL offers its route charge service to any state, that is interested in using it.

The main advantage of CRCO is its simplicity. Fees are payable per flight, in one currency to one organization. The system is also equitable; the more you use the airspace, the more you pay. Everyone is charged according to the frequency of their flights. At the same time, every state is paying the same fee and identical rules are applied. Only ATM costs are charged, and the collection costs are low. CRCO's technical support CEFA means a ceaseless access to all the information such as current fees, individual billing data and contact details. It also enables states to monitor and process their claims quicker. [17]

3.3.7 EUROCONTROL's agreements

Apart from its members, EUROCONTROL integrates many states and interacts with them on different levels. There are 2 comprehensive agreements, that let Israel and Morocco join the network manager structure. Other states belong to the group of so-called partner countries and have different bilateral and multilateral agreements regarding route charges (Belarus, Egypt, Uzbekistan), establishment of a framework for mutual cooperation (Brazil, Canada, China, Iceland, Russia, the USA), exchange of information for ATFCM (Belarus, Egypt, United Arab Emirates) or operational and technical assistance (Thailand). [9] The biggest group of non-member states is created by countries with EAD agreement. EAD, as mentioned in 3.3.4, is a European AIS Database. The agreement states the provision of data from individual countries, sharing information from the EUROCONTROL side and the right to use all information for operational purposes. Signatories of the EAD agreements are Azerbaijan, Belarus, Canada, Jordan, Kazakhstan, Kyrgyzstan, New Zealand, Philippines, South Africa and Taiwan. A respective map from EUROCONTROL's website can be seen in Figure 4.

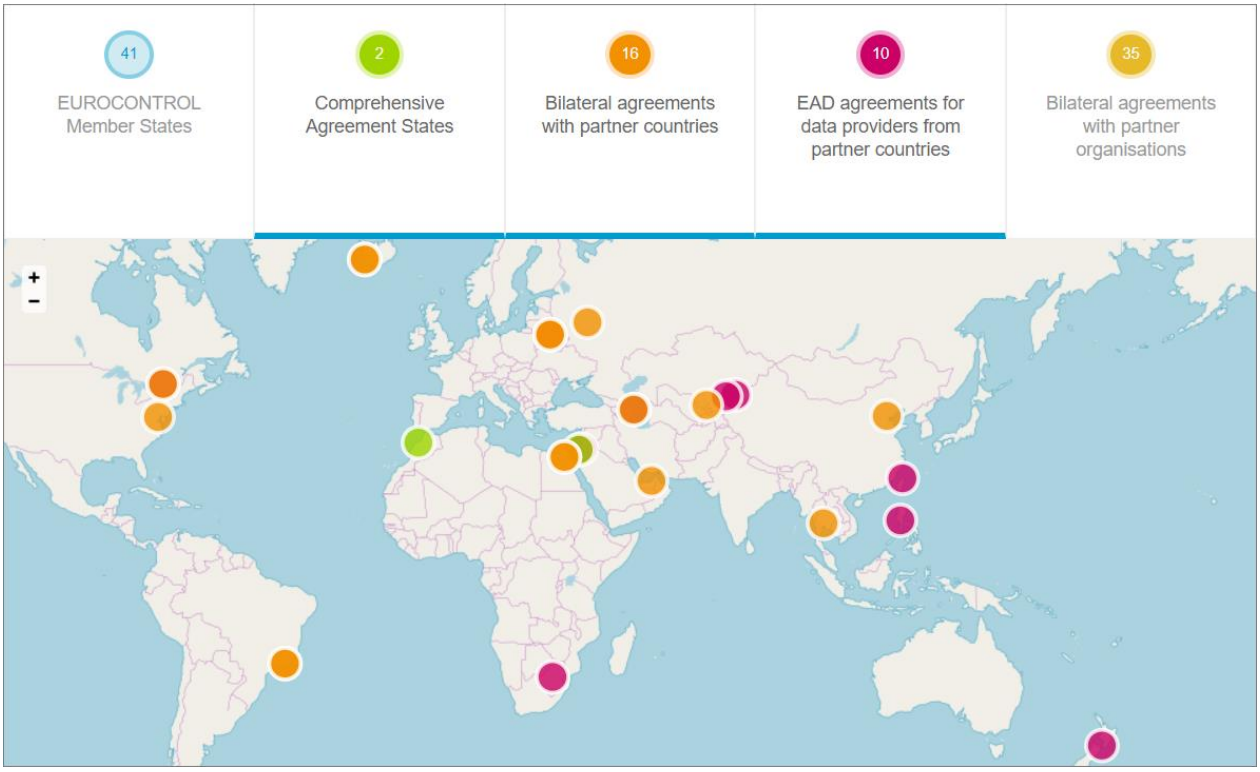

Figure 4: EUROCONTROL's Agreements [9]

3.3.7.1 NM Areas of Operation

Member states and countries with deeper agreements and stronger EUROCONTROL bonds are included within the area of its influence. The main areas of NMOC are NM Area, ATFM Adjacent Area (ATFM Adj) and ENV Extraction.

The NM Area includes FPM Distribution Area (IFPZ), FPM Copy Distribution Area (FPM Copy), RSO Area (CRCO) and ATFM Area. NM Area is a technical area where FPLs are analyzed and their relevance for NM or CRCO operations is decided.

IFPZ is further discussed in chapter 4. FPM Distribution Area is an area, where received and relevant FPL are sent by IFPS. However, the NM is not responsible for validation of the FPL content distributed to these countries. If an aircraft enters this area, the Aircraft Operator (AO) is obliged to send their FPL to IFPS and IFPS will distribute the FPL to the addresses mentioned in the FPL. RSO Area includes all states using CRCO services. ATFM Area is an area, where NM is responsible for ATFM.

Any flight departing ATFM Adjacent area entering ATFM Area is considered by the ATFM and regulated accordingly. Iceland, Belarus, Egypt and Algeria belong to this area. With the purpose of trajectory predictions, ENV Extraction Area is defined as the area, in which the route-related information in the FPL is guaranteed. [18]

4. IFPS Zone

Chapter 4 is devoted to the present IFPS Zone. It describes its functioning, includes the current list of states and discusses its extension mentioning general reasons, advantages and disadvantages of the whole system. Attached is also the list of requirements for IFPZ entrance. Morocco and Israel, two IFPZ members, were chosen to be evaluated in terms of their affiliation, using past statistics and future forecasts.

4.1 IFPS in the IFPZ

"The area included in the flight planning and message distribution service is known as the IFPS Zone." [19] IFPZ is an ICAO EUR region where IFPS is responsible for receiving, checking and distributing FPL messages. IFPZ belongs to the Network Manager area of operation.

Flight plan processing is one of the many but very important services that NM offers. Every flight departing, arriving or overflying EUROCONTROL NM operations area has to have a flight plan. The FPL message is sent to NMOC. With the help of IFPS, NMOC checks and analyses the flight plan before the departure. It makes sure the flight plan is correct and satisfies all regulations. Staff can suggest any alternative routes that could lead to time or fuel save and, also, forwards the copy of the flight plan to all air traffic control centers that will be affected by this particular flight. There is also a periodic re-validation to ensure smooth flow – changes due to weather conditions, technical problems or airport control centers are taken into account, as well as the latest opportunities such as re-opening of certain airspaces due to several reasons.

4.2 How the System Works

4.2.1 Flight Plan Submission

As mentioned before, every flight interacting with EUROCONTROL operations area (even in the smallest manner) must submit a flight plan to the centralized system managed by NMOC. The communication runs with the help of SITA and Aeronautical Fixed Telecommunication Network (AFTN). This procedure is valid for any of the following cases:

1. Flights from IFPZ to IFPZ
2. Flights from IFPZ to non-IFPZ
3. Flights from non-IFPZ to IFPZ
4. Flight from non-IFPZ to non-IFPZ overflying IFPZ

ICAO Annex 2 and Documents 4444 and 7030 define the basic requirements and rules for sending FPLs and associated messages. Within the IFPZ, NM is responsible for all received flight plans. These are submitted to two centers:

- Haren (Brussels)
    - Departures from northern Europe, RPLs, AFILs
- Bretigny sur Orge (outside of Paris)
    - Departures from the rest of Europe (flying to Europe) + countries surrounding IFPZ

Even though the centers are divided and have their specific tasks, FPLs have to be sent to both of these units. In case of one's failure, they can replace each other. It is therefore ensured, that the service of flight plan processing is provided 24/7, without any disruptions.

4.2.2 Flight Plan Validation

With the use of IFPS, NMOC checks FPLs using the airspace structure. Before the flight plan can be accepted, all requests need to be analyzed and system makes sure that everything is compatible. FPL messages are checked in terms of the compliance with the ICAO and EUROCONTROL rules and regulations, it is controlled, that they are complete, and their structure is acceptable for all traffic services. Operational reply messages (ACK, REJ or MAN) are sent back to FPL initiators to share the submitted flight plan status. In case of any change, associated

messages are communicated. The process of IFPS-Operator interactions is further described in chapters of 5.3.4. and 5.3.5 of the Bachelors' thesis. [1].

According to the EUROCONTROL's website "*The Network Manager Operations Centre receives, processes and distributes up to 90,000 flight planning messages a day. This concerns over 500 European airports and airfields."* [20] Also, only in about 2% of the cases manual interventions are needed, the rest happens automatically [20]. Once the FPL is accepted, it can be then distributed further along the way.

4.2.3 Flight Plan Distribution

Every accepted flight plan is distributed to all relevant air traffic services units that are affected by that particular flight. Chapter 4.2.1 describes 4 different routing scenarios. In the first one, when the flight is operated only within the IFPZ, validation and following distribution of FPL is logically a task for IFPS only. Situations 2 – 4 apply a very similar process. It is obligatory for the FPL to be firstly sent to IFPS, and only after its acceptance by IFPS, it can be distributed outside IFPZ. This means, that every time, when an aircraft route plan enters IFPZ (non-dependable on what part of the flight it is, when and for how long in comparison with other airspaces it is), the first validation is made via IFPS. Therefore, sharing a non-valid FPL is avoided. If this procedure was not followed, it could easily happen, that the flight plan would be accepted by other FIRs, but not by IFPS. The flight could then take off without a valid IFPS FPL and this would create a problem for European centralized system of air traffic management. [21] The description of the process, included in the IFPS Users' Manual, can be seen in Figure 5.

Regarding the distribution outside the IFPZ, there are two possible scenarios. In the first case, FPL is automatically sent further by IFPS – this procedure comes to place, if an operator adds an "AD" line directly into the FPL. The AD line includes AFTN addresses, where the flight plan is supposed to be distributed to. In the second case, operator sends FPL to the IFPS and when an ACK message is received, initiator's planning software forwards the FPL to the affected FIRs outside IFPZ. [21]

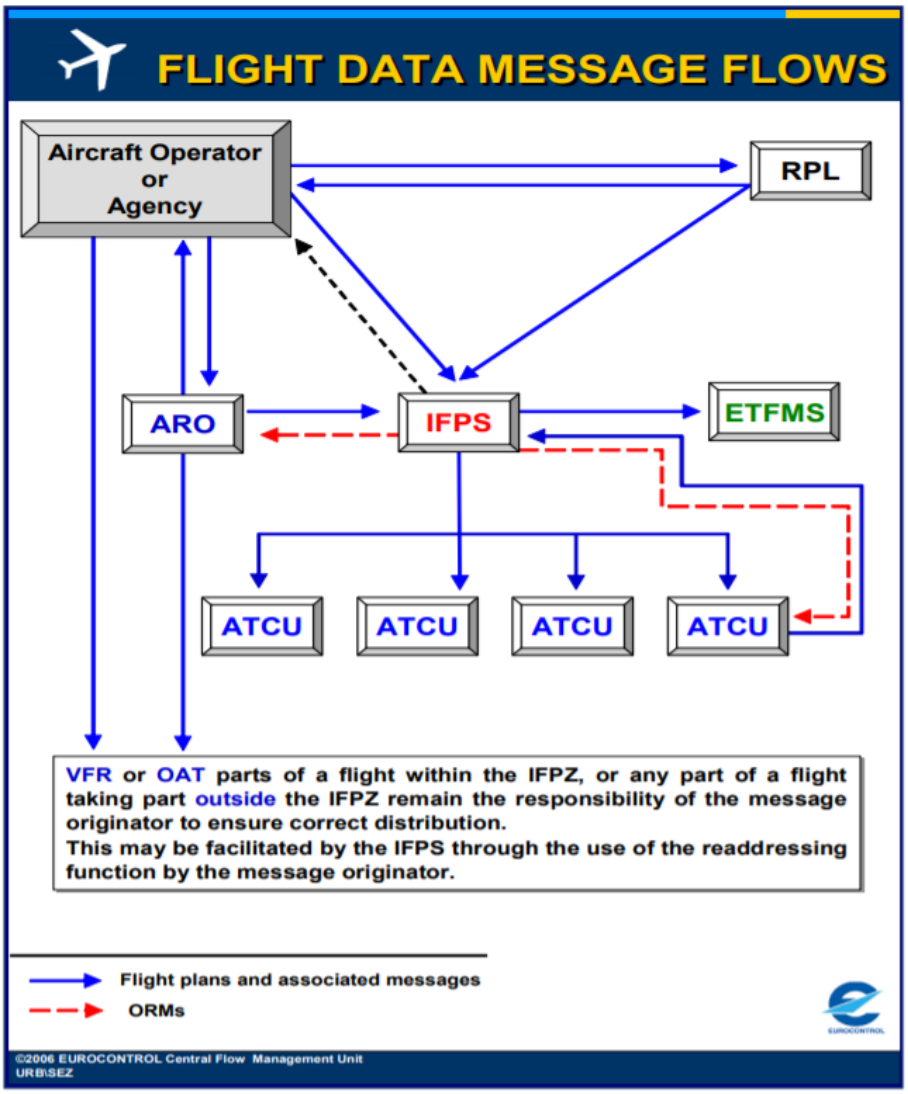

Figure 5: Flight Data Message Flows [1]

4.3 States within the IFPZ

Being part of IFPZ means being part of FPM Distribution Area. Today, in 2019, IFPZ counts 43 states (technically 44, but Serbia and Montenegro are united within Belgrade FIR). Among these, there are all 41 of EUROCONTROL member states (see Figure 3). Most of them joined EUROCONTROL before the IFPS establishment and they became part of IFPZ automatically. Apart from EUROCONTROL member states, by 2019, three other countries joined IFPZ – these are Morocco (5th June 2008), Azerbaijan (7th of January 2015) and Israel in (22nd of June 2017).

Morocco was the front runner and the agreement regarding IFPS provision was the first initiation of any cooperation with the organization. Azerbaijan and Israel had been previously partner-countries and cooperated with EUROCONTROL via agreements connected to international air traffic management and air traffic control cooperation.

As mentioned in chapter 3.3.7.1, airspaces that are not the part of IFPZ but get FPLs copies from NMOC are called FPM Copy. A map showing the respective area borders can be seen in Figure 6.

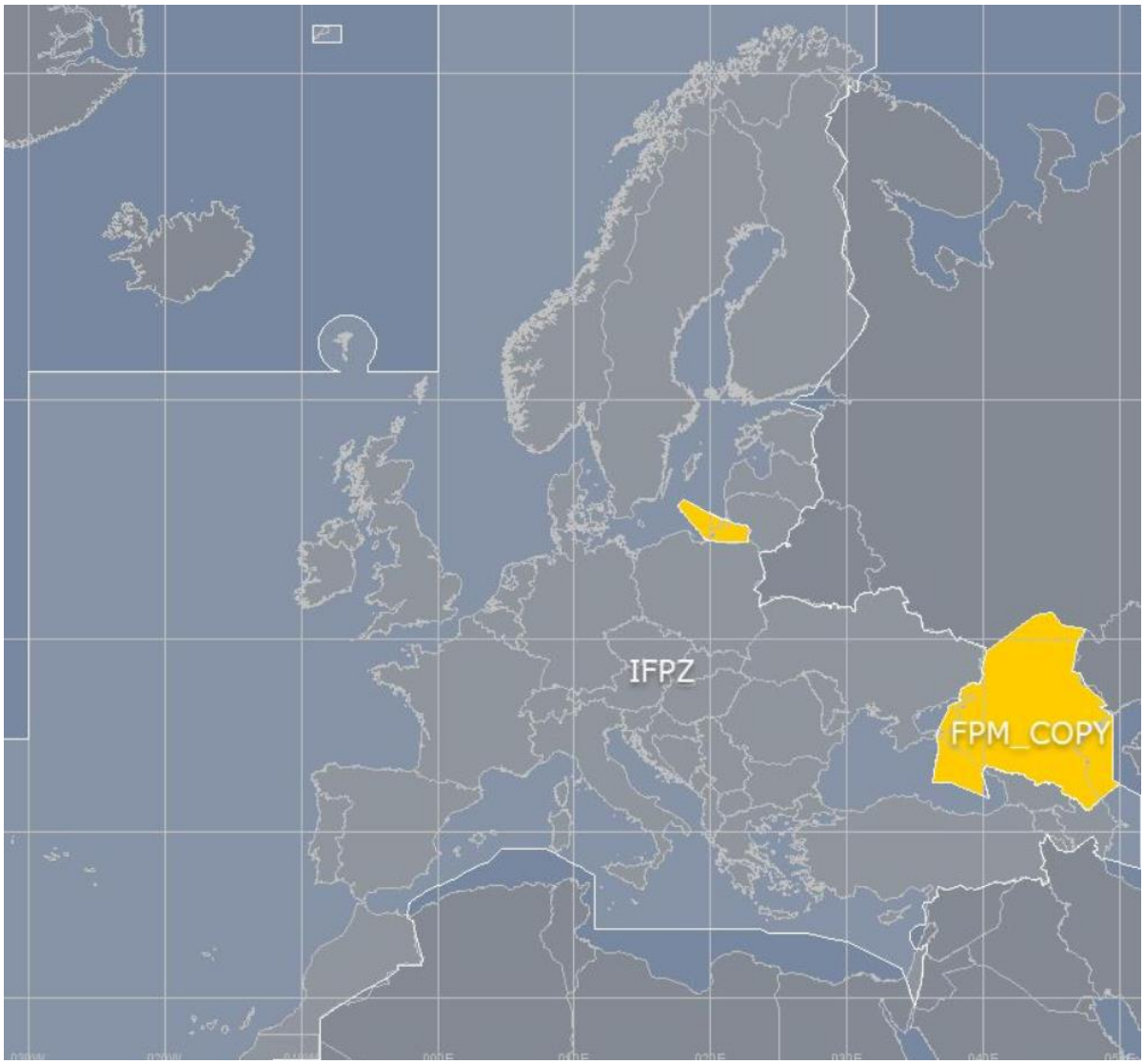

Figure 6: NMOC Operations Areas [18]

4.4 IFPZ Extension

4.4.1 Why should IFPZ be extended?

Without doubt European air traffic is increasing; every single year, month and almost a day. Throughout the history, annual reports, titled with shockingly high numbers, appeared in every single year since the organization started keeping track. The traffic increase in the past 4 years can be seen in Figure 7. As Joe Sultana, the Director of the Network manager said in 2017: "*The European ATM system is now handling record numbers of flights. This demonstrates how important the pan-European network approach is for managing our busy skies.*" [22]

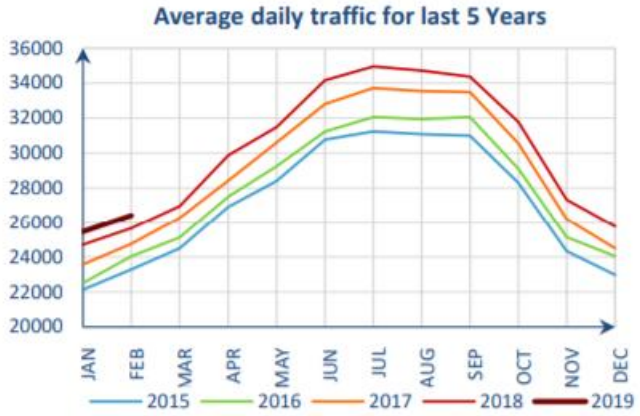

Figure 7: Average Daily traffic for the Last 5 Years [22]

Looking at 2018, the last EUROCONTROL's statistics state: *"Europe's air traffic increased by 3,8% in 2018, compared with the year before, to reach an all-time record of 11,011,434 flights, with daily average traffic of 30, 168 flights."* [23] According to the most recent predictions, a similar growth is expected even during the next years. In February 2019, EUROCONTROL's Statistics and Forecasts service (STATFOR) updated the former seven-year forecast for the period of 2018-2025. STATFOR states, that 2019 should bring a growth of 2.8%, meaning the total amount of 11.31 million flights. 2020 expects a growth of 3% and a total of 11.65 million flights. During 2021-2025, the average of 1.8% growth is predicted. According to the EUROCONTROL report, the growth is still likely to increase, and reach 12.67 million flights at the end of 2025. Considered are facts like Brexit and pressure on the airlines in terms of environment and safety. [24]

On the one hand, it is desired of air traffic volumes to be on the rise; but on the other hand, with this growth, Europe experiences a major airspace capacity problem and there has been a dramatic increase in flight delays and cancelations. Issues, that were handled well enough but not perfectly in the past, are getting bigger in the present and call for more attention. Problems connected to different flight planning and flight plan processing represent a significant portion of all delays. Stated below are the most frequent challenges:

- Variant FPL processing/filling time, different rules
- FPL incompatibility
- CTOT for out of IFPZ flights
- Communication ATC-operator (sometimes none)
- Various distribution addresses

NM is trying to address all delays using multiple projects and activities. Main ATM projects contribute to the optimum capacity and efficient flight planning. Better CDM at local levels, synchronized solutions and sharing information is essential. In other words – the more we cooperate, the better results we get.

EUROCONTROL tracks FPLs and looks for areas with capacity bottlenecks; these require special attention. The traffic is quickly rerouted in the most convenient way. However, if any FIR outside the IFPZ cannot manage their demand at a time, casual regulations are applied unexpectedly. These adventitious situations cause air traffic delays. Due to airspace segregation, individual ATC systems and diverse regulations in place, quick and efficient reaction represents a challenging task. Centralized FPL processing, followed by increased capacity, is needed to manage the sheer volume of traffic. [25] The idea of a cooperative flight planning works very well within ICAO EUR region, and, undoubtedly, there is potential for its expansion. Some non-European countries already joined IFPZ or cooperate with EUROCONTROL at different levels. According to the forecasts, within the next decades, almost 90% of all European flights will be heading out of the continent. Other parts of the world will experience the same situation in no time. Therefore, interconnection between neighboring regions is crucial and essential. IFPZ is an important step towards bright aviation future.

4.4.2 Advantages of being an IFPZ member

Previous chapter mentioned benefits of IFPZ as reasons for its extension in terms of the whole system functioning. The next few lines describe the advantages of IFPZ for its members. Discussed are following topics:

- FPL's content consistency
- Submission solely to 2 addresses & Automatic Distribution
- IFPUV & Ensuring FPL correctness
- Reliable system of operational reply messages
- Access to Data & Situational awareness
- Smooth air traffic flow (CTOT system)
- Access to past FPLs database
- Staff training
- Technical support from EUROCONTROL
- Simplification for private pilots

Firstly, being an IFPZ member means being part of a centralized flight plan processing system. That brings the benefit of consistency; all flight plans have the same structure. Everyone understands and knows exactly, where to look for desired information. Controllers quickly familiarize themselves with the data and operators do not have to worry about incorrect interpretation. Furthermore, the planning itself is much easier, as the same basic rules can be applied for majority of flights.

One of the most significant advantages is the simplification of FPL submission in terms of AFTN addresses. For flights within IFPZ, FPLs are only sent to two EUROCONTROL NM units (Brussels and Bretigny), irrespective of routing. The distribution of accepted FPLs and RPLs is covered by IFPS. The system therefore decreases workload of flight planners, who do not have to look up all affected ATCUs' addresses.

Thirdly, IFPS ensures flight plans' correctness as it automatically checks every single FPL message that arrives. Moreover, prior to submission, flight planners can make use of a non-operational validation tool (IFPUV) to find out, if their FPL will be accepted. IFPUV is an automated testing system with selfsame structure as IFPS. After submission, an immediate answer is generated. If everything complies, the system gives it a green light. In case of an error, the problem is specified. Sometimes, it is able to automatically offer one or more solutions to make the FPL

acceptable. Although IFPUV is a direct copy of IFPS, it is not connected to the operational system [26]. It is just a supportive tool and all FPLs still have to be sent to IFPS. Flight planners from ABS Jets and Smartwings stated, that IFPUV represents one of the main advantages of any IFPZ-member state [21, 27]. Meanwhile, in other parts of the world, flight planners rely on aviation maps or recommendation of locals. They constantly check FIR's NOTAMs and new or short-term restrictions and limitations, which need to be taken into consideration while planning the route. That makes the process slower and more complicated. The same applies to AUP/UUP or CDR. All these procedures are much easier within the IFPZ [21].

Another benefit represents the reliable system of operation reply messages (ACK, REJ, etc.). Feedback is provided immediately after FPL submission and informs the initiator about acceptance, rejection or manual changes being conducted. In case of rejection, the reason is specified. Also, after receiving ACK message, one can be certain, that FPL is taken into account and it has a place in the system. In some parts of the world, no response service is provided, and crews are not informed about any issues till the last minutes. Missing or incorrect flight plans come to light before take-off, when no clearance is granted. Delays are unavoidable as it is too late for any changes.

Being a member of IFPZ and therefore being a member of IFPZ distribution area also means the access to wide repository of data, which supports efficient flight planning. Due to the centralized system and information sharing, operators can monitor current situation and plan accordingly. Thanks to bilateral agreements, even non-IFPZ states have access to this data. However, the more information is shared centrally, the more accurate the system can be. As EUROCONTROL stated: *"Maximum consistency and the rapid updating of flight plans are essential in maintaining an accurate picture of demand throughout the European ATM network - and in defining the impact this demand may have on capacity. Having this clear picture is the aim of our centralized flight plan processing and distribution service."* [28] IFPS also supports situational awareness. The system continually informs dispatchers about any unexpected regulation; possible events might be insufficient airspace volume or lack of ATC capacity due to weather conditions, staff strikes, etc. This feature is very helpful; an adequate response can be created quickly. Unfortunately, in some parts of the world, for instance in China, operators are commonly unaware of what is happening – flights are suspended, and nobody knows why. One waits, uninformed, as he/she is dependent on the ATC instructions. Only afterwards, the reasons are discovered. [27]

Connected to the previous benefit of situation awareness is the slot allocation process applied within (but not only) IFPZ. Calculated Take-Off Time (CTOT) ensures efficient and continuous air

traffic flow with the use of information from the FPLs. Even in this case, the communication System-Operator runs perfectly. A detailed description of Computer Assisted Slot Allocation (CASA) is included in chapter 5.3.6 of the Bachelors' thesis. [1]

Information about every executed flight is kept in the database. Access to this data storage is another big advantage for IFPZ members. Past flight plans can be found and reviewed for various reasons.

Staff's acquaintance with IFPS is fundamental for a smooth running of the whole system. It is the responsibility of EUROCONTROL, as the network manager, to provide sufficient training for all actors included. The organization uses a bottom-up approach; it is ensured that every single worker gets access to complete information and performs well at a local level. As individuals cooperate, an efficient system is built up, all over Europe. There are different types of training – e-learning, classroom courses and self-study guide books. Member states can exploit these resources as fully as possible; train new employees and keep current staff informed about new trends and developments. All materials and seminars are free of charge as they are paid from the EUROCONTROL Work Program.

The organization also offers technical support for all its systems, including IFPS. Necessary software is maintained centrally and includes many helpful subsystems for local use. Updates are automatic. Countries can benefit from this also in terms of improving own infrastructure and operations.

According to Benoit Houot, one of NM's Operational Advanced Support Specialists, country's entrance into IFPZ means easier flight planning for airlines, because they can file directly to IFPS. For states themselves, IFPS represents a huge and reliable flight plan processing system where FPL examination, validation and distribution are precisely executed. IFPZ membership also opens door for further cooperation in terms of bilateral agreements with EUROCONTROL. [29]

4.4.3 Disadvantages of the IFPZ

Although IFPS represents a huge support for countries and airliners, and is of great significance for centralized flight planning, it is necessary to mention a couple of weaknesses. Some of them are successfully reduced by certain system functions, others require special attention.

One of the disadvantages when planning flights in the European Union is the amount of restrictions (RAD and others). One cannot fly freely via the best route possible as it is necessary to consider everyone involved and apply CDM concept. IFPUV represents a huge simplification in this manner. [21] Slot limitation might be another bottleneck on the way. [27] Although some of the partner countries cooperate with EUROCONTROL NM and follow its orders, the CTOT system can fully work only if everyone is included. That way, rules are the same for everyone and no preferential treatment is ensured.

IFPZ membership also comes with a problem, that is identical to all centralized systems – potential breakdown. NM's continuous access to FPL database is essential for the ability to manage and harmonize air traffic flow. If the system collapses, as it happened recently, the consequences are significant. On the 3rd April 2018, two European systems ETFMS and IFPS stopped working, both in Brussels and in the contingency center in Bretigny. The issue was caused by the FPLs receipt outage, which lasted approximately 2.5 hours. However, even after restoration of the whole system, all previous FPLs were lost. AOs needed to send their FPLs again and that created confusion and an extended delay. Safety of air traffic was kept due to an immediate application of a contingency plan, however, the capacity was lowered by 10% and delays all around Europe increased up to one hour. [30]

Indirect effects of IFPZ entrance might also include the transformation of overflight fees. Even though CRCO service is not unavoidably connected to IFPZ, majority of the member countries make use of it. In general, EUROCONTROL tends to lower overflight fees with the aim of making air traffic cheaper and more accessible. To survive in the competition, new members would most likely need to conform to the standard and lower their fees.

Lastly, many out-of-Europe occasional pilots, struggle with IFPS. [27] This applies especially to operators from the USA, where another well-functioning flight plan processing system, En Route Automation System (ERAS), was established. As the European and American systems are both very specific, but not fully compatible, flight planning can be challenging. Differences and issues coming from these irregularities are discussed in depth in the text of the Bachelors' thesis. [1]

With respect to all advantages and disadvantages of IFPZ and considering the current situation in the world of aviation, the benefits far outweigh any risks and potential problems of the system. In general, expansion of any bigger centralized structure is the key to flight plan processing efficiency.

4.4.4 IFPZ – Integration Requirements and Process

EUROCONTROL NM Operations area is open to any state, and considering the air traffic prognosis, IFPZ expansion is highly desired. Integration into a centralized structure involves standardization process and adjustments to system's requirements. In the next few lines, necessary procedures are discussed step-by-step with the support of the integration checklist provided by EUROCONTROL, that can be seen in Figure 8.

Integration of State to NMOC - Check list
Integration Coordinator:

IFPS Services **Planned date of start:**

	Task	Who?	By?	Status
1.	Appoint ENV coordinator	State		
2.	**Airspace Data**			
	• Environmental (ENV) Data + FPL Distribution addresses from AIP/ ENV Coordinator into CACD			
	• Integration in corresponding NM Operations Area(s) into CACD			
	• RAD Data from National RAD Coordinator (If required)[1]			
	• ASM Data (AUP/UUP) from AIP / AMC (If required)			
	• Data insertion & pre-validation for IFPS			
3.	**Flight Planning Services**			
	• Update to IFPS User's Manual/OPS Instruction			
	• Publication of AIM/NOP for flight planning			
	• E-mail to AOs and CFSPs			
4.	**Training**			
	• Training of State's FPDS / ARO / AO staff.			
5.	**Agreement for the provision of IFPS services – possible together with financial aspects.**			
6.	**Publications**			
	• Drafting of AIP/AIC			
	• Publication of AIC (State)			
	• Publication of AIP amendment (State)			
	• Issue of NOTAM (State)			
8.	**Start of IFPS Services**			
9.	AFP (ATC Flight Plan Proposal)			

Figure 8: Integration of State to NMOC – Check list [29]

Prior to the integration process itself, the future IFPZ state is assigned to a coordinator from EUROCONTROL. This delegate represents NM in terms of information provision and necessary support. In addition to this, his role is to ensure, that all tasks from the checklist are fulfilled.

To start with, a National Environment (ENV) Coordinator is appointed. ENV Coordinator is responsible for several tasks; he is the bridge between NM and ANSPs. Airspace pre-validation can begin as necessary airspace data are shared with various NM systems to be examined. Required information can be seen in Figure 8 under Task 2. Environmental data and FPL distribution addresses are incorporated into Central Airspace and Capacity Database. If needed, ENV Coordinator has to be capable of explaining and further describing anything, that is found discrepant or incorrect. Gathering necessary information continues with RAD data, Airspace Use Plan (AUP) and Updated Use Plan (UUP). The ENV Coordinator supervises the transmission and participates in the CACD validation process including IFPS pre-validation sessions. [31]

The third task involves Flight Planning Services. For any country integrated into IFPZ, Civil Aviation Authorities need to follow the IFPS User's Manual Handbook, that gives a complete description of the whole system and all procedures. Therefore, if a new country enters the structure, the document has to be updated. In addition, all flight planning instructions and changes against the former country's system have to be accessible for everyone affected by the transition. AOs and Computer Flight Plan Software Providers (CFSPs) need to be informed.

Following is the staff training. As mentioned in chapter 4.4.2, the training is free of charge. Depending on the country and its current level of cooperation with EUROCONTROL, various courses are offered either to broaden existing knowledge or start from scratch. Therefore, the duration of complete training varies from state to state.

The IFPZ entrance becomes official and valid only after signing an agreement about IFPS provision; its preparation is one of the checklist's tasks.

Publications update is another important part of the transition. Aeronautical Information Publication and Aeronautical Information Circular (AIC) are drafted by the Integration Coordinator, state's coordinator publishes AIC, AIP amendment and NOTAM.

When all tasks are checked, IFPS can start fulfilling its function. AFP (ATC Flight Plan Proposal) can be submitted. AFP is a message sent to the system by an air traffic services unit, which uses new or updated flight information. IFPS responds with APL (ATC FPL message) when no FPL like that is in the system or ACH (ATC FPL Change) if the route from AFP is different from a route of a flight plan already stored in the system. Now, the integration is complete.

4.5. Member-States' Examples

To support the points stated in the first part of this chapter, two member-countries were chosen and put under analysis. These are Morocco, the first non-European state to enter; and Israel, the last one to be integrated. In both cases, the situation prior to IFPZ entrance is described, followed by reasons for joining, transition process and its challenges. Concluded is the current situation, transitional benefits and future air traffic forecast.

4.5.1 Morocco

4.5.1.1 General Introduction

Morocco is the front runner in Maghreb countries in terms of successful liberalization of air transportation thanks to an agreement signed with the European Union in December 2006. *"Perhaps the biggest game-changer in Moroccan air travel since the turn of the century was the signing of the Open Skies Agreement with the EU in 2006, which liberalized the rules and regulations governing international aviation between the kingdom and the bloc."* [32] The agreement about Open skies between the EU and the Kingdom of Morocco was the first Euro-Mediterranean Aviation contract. Morocco opened its airspace and the market was immediately attacked by new operators and, also, by low-cost business. All EU's and Morocco's airlines were able to fly directly between any aerodrome within the respective areas. The volume of international tourists more than doubled since 2000 and almost hit the vision of 10 million arrivals for 2010. The 2006 agreement not only opened doors for business and industry, but also created a developed framework and higher standards for several aviation-related topics such as competition and economy. [32] Regarding the cooperation with EUROCONTROL, Morocco entered IFPS Zone on the 5th of June 2008 following an initial cooperation agreement. [33,34] In 2016, a comprehensive agreement about strengthening cooperation was signed. *"The Kingdom of Morocco was fully integrated into EUROCONTROL's working structures and is able to benefit from all services the Agency provides."* [35]

Casablanca FIR lies in the northern part of the African continent. It borders with FIR Lisbon, FIR Madrid and FIR Canarias; these are IFPZ members. Other neighbors are African areas Alger FIR and Dakar FIR. Respective maps can be seen in Figures 9 and 10.

Figure 9: Morocco on the Map [36]

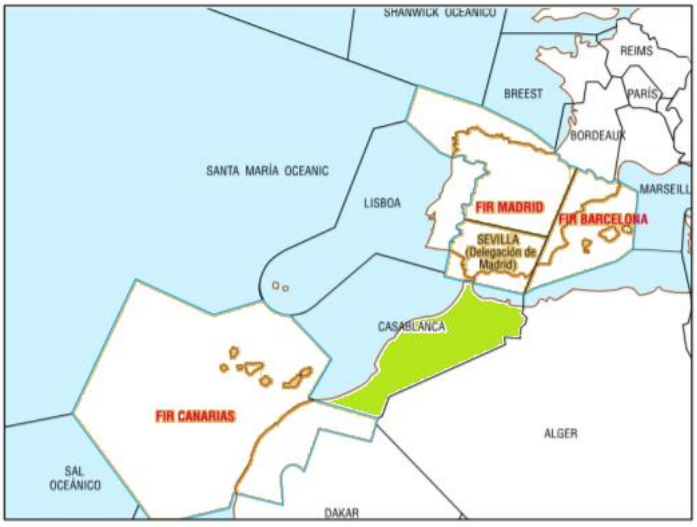

Figure 10: Casablanca FIR on the Map [37]

4.5.1.2 Before 2008

The period between Morocco's liberalization of air traffic and its entrance into IFPZ was not long. However, despite the process simplification being on its way, European operators needed to follow identical procedures to any other country outside IFPZ.

According to the AIP, flight plan needed be submitted at least 60 minutes prior to departure via ARO at the local aerodrome. FPLs and other associated messages were sent to two main addresses for Casablanca FIR and one additional one dependable on the routing of the flight. Operators departing from Europe firstly validated their flight plans via IFPS, and after receiving ACK, they could forward the message to respective Moroccan addresses. In addition, Morocco required obtaining overflight and landing permits in advance. Unless a valid permission number was stated in the FPL, Morocco did not accept it.

4.5.1.3 Reasons for IFPZ Entrance

Due to its location, Morocco was always seen as the bridge between Europe and Africa. Since opening its skies in 2006, the traffic more than doubled and a reaction was needed to address the

demand. Moreover, further forecasts stated that the increasing trend will continue and with the vision of another 50% increase by 2010, certain actions needed to be taken. Moroccan authorities saw the potential and wanted to ensure, that they would be able to handle future air traffic in the best possible way. Future cooperation with Europe was a logical step and adherence to a centralized flight planning and flight plan processing was the first move towards EUROCONTROL's integration.

At the same time, EUROCONTROL, as a provider of effective and efficient network, continuously tried to improve its services by developing new partnerships and agreements. Morocco represented a great nominee as it directly bordered with IFPZ and its airspace was (and is) heavily used by many European operators. Since 2006, Casablanca FIR has been used for flights to South America, especially Brazil and Argentina, for flights to Canary Islands and, also, to Sub-Saharan Africa. Additionally, Moroccan airspace has been an important connecting route for Italy.

The main driver of the Europe-Moroccan cooperation was the increase in the airspace capacity. With continuous sharing data process, the airspace could be used in the maximum possible way. Simplified process for airlines and travelling public was another reason; these entities were about to enormously benefit from Moroccan transition, as they could use the same FPL submission and distribution process as they did within Europe.

4.5.1.4 Transition Process and Changes Made

Morocco officially entered IFPZ and CFMU (former NMOC) in 2007. Since 2008, IFPS started fulfilling its function as the processor of flight plans and other associated messages. Morocco also adopted ADEXP format, that is needed for operation within the IFPS Zone.

Based on the NMOC procedures, all flight plans affecting Moroccan airspace should be submitted to 2 EUROCONTROL addresses. The necessity to obtain overflight and landing permits stayed the same. Moroccan AIP was updated and explanation of IFPS was included in ENR 1.9 as the Communication with CFMU.

4.5.1.5 IFPZ Status and Confusion

Even though Morocco is officially a part of all European aviation system-related maps, its IFPZ status can be slightly unclear. After discussion with couple of flight planners from different airlines

within IFPZ, it seems, that rules are different for certain operators and certain destinations. While briefly browsing through FPLs in the NOP, for local routes operated only within the borders of Morocco, flight plans are always submitted to EUROCONTROL and the process is identical with any other IFPZ country. However, if a flight departs from Morocco and it is not routed via European airspace (IFPZ), two possible scenarios occur. In some cases, FPLs are distributed via IFPS; in other cases, IFPS does not play any role at all.

According to Turkish Airlines, Morocco has a status of an adjacent country and all FPLs operated within the Casablanca FIR airspace are sent directly to Moroccan AFTN addresses. Therefore, Turkish Airlines do not take Morocco as an IFPZ member and their flight planners follow specific distribution procedures stated in the Moroccan AIP. [38] Czech airline Smart Wings also does not consider Morocco as a part of IFPZ. [21] However, according to the ABS Jets, when planning flights via Moroccan airspace, FPL distribution runs via EUROCONTROL and even locally, within the borders of the country, operational messages such as ACK, REJ, etc. are received. [27] In addition, ABS Jets does not experience any significant problems with FPL submission, the same applies to flight plan distribution. Everything runs smoothly via IFPS. The only difference from other IFPZ countries is the fact, that Morocco still requires obtaining landing and overflight permits. Lufthansa stated the same information.

EUROCONTROL's representative stated the general rule, that FPLs should be filed directly to IFPS only if authorized by the state concerned. And that is the reason for different procedures followed when flying to aerodromes outside of IFPZ. [27] Attached is supportive documentation for this statement. Firstly, a paragraph from IFPS User's Manual (Attachment 1). And secondly, FPL from 17th of May 2019. (Attachment 2) The respective flight departs Morocco and heads south. Therefore, it does not even cross the European border. Its flight plan is still submitted to IFPS. Attached is also a print screen of automatic distribution to Casablanca, that is made via IFPS.

It is possible, that Moroccan IFPZ status got confused due to insufficient information flow. Many private pilots, who use FIR Casablanca for the first time, find it very difficult to find the right steps for FPL submission and distribution. Moroccan AIP is a voluminous document and its information are not easy to follow. A recommendation for Morocco would be to re-write the AIP. The current version is slightly unclear, possibly due to many updates, recently made regarding EUROCONTROL's structures integration. FPL submission to IFPS is now included in ENR 1.9 (ATFM) as a necessary step in the process of slot allocation. ENR 1.10 (Flight Planning) mentions IFPS briefly in couple of paragraphs as a matter of communication for changes in the flight plan,

but part 1.1 d) place of submission states, that FPL should be submitted to ARO at the departure aerodrome. ENR 1.11 (Addressing of flight plan messages) lists Moroccan ATFM addresses and mentions, that for flights to or via Europe, 2 IFPS addresses must be added beside the usual ones. There is no definite statement about Morocco using IFPS as a centralized flight planning and flight plan processing system. The AIP is confusing especially for private pilots coming from the outside for the first time. In addition, according to their statements, Moroccan authorities do not send feedback for submitted flight plans. It is then possible, that their FPL does not go through and they only realize it once the clearance is not obtained. These situations create lots of confusion and unnecessary delays.

One of the main ideas of a centralized system is the process simplification; the fact, that pilots do not have to read the whole AIP to find out, how, when and where to file FPL. Therefore, the information given should be well-arranged and understandable to ensure everyone can benefit from the system.

4.5.1.6 Integration Benefits

Despite the misunderstandings mentioned in 4.5.1.5, Morocco's entrance brought several benefits. IFPZ integration means adherence to a centralized system, that is common among the whole European network. Therefore, Morocco can receive assistance in terms of air traffic and flow management. Due to its requirements, IFPS system also upgrades aviation safety which is one of the main efforts within the whole aviation network. Offered staff trainings and, also, having the ability to share knowledge and experience, are general benefits of any centralized systems. Except for local investment programs and action plans, NMOC integration significantly contributes to its members' development. Airspace units are converging and technical provision, common airspace design and universal air traffic control procedures are essential for future improvements in this domain.

IFPS also comes with significant operational advantages. The growth of air traffic from Europe will be even quicker and more noticeable if European airlines plan easily and more efficiently. This applies to both, flights with the destination in Morocco or others routed via Moroccan airspace, where overflight fees are collected. The flight demand is high and with improved predictability in planning daily operations, which is one of the benefits of full integration, operators can add more flights and bring more tourists. Also, there is a growing competition with countries next to Morocco, which are trying to attract European airlines companies and route more passengers via their

airports. Tourism is an important financial source for Moroccan economy and IFPS adherence create a huge advantage in these manners. More flights mean more money and therefore funds for further infrastructure development and increased capacity. In 2016, the Chief Executive Officer of Moroccan Airport Authority, Zouhair Mohammed El Aoufir, said, that they are very satisfied with the agreement. Cooperation with EUROCONTROL saves time. It is a permanent exchange, being part of a group means developing performance, new routes and sectors, relationships and interfaces between navigation services and spaces. [39]

Not only competition from countries at its borders, but also and increased favor of local road and rail freight transport is attacking Moroccan monopole. Easier flight planning and being part of a bigger, safer, faster and more efficient system brings another plus in terms of choice of air traffic for freight transport.

Lastly, strategically for EUROCONTROL, Morocco represents an important connection to the African continent. It could serve as an example for other countries and it could lay the foundations for an African part of IFPZ.

4.5.1.7 Disadvantages

The first potential disadvantage is connected to the last benefit mentioned – Morocco is a bridge between technologically advanced European continent and some developing countries in Africa. That would explain the inconsistencies in FPLs submission and distribution. For instance, central Africa might technically not be able to process messages coming from IFPS or communicate other messages on the same level, when needed. Therefore, it is easier for Morocco and these countries to stick with the old system of reporting the flight plan directly to the authorities, that are affected. Also, for these flights, it might not make sense to send the flight plan to Brussels – simply because there is no reason for Europe to know. The flight would not cross any part of their area of operation, except for departing Morocco, the ATFCM does not need this information and therefore there is no benefit to it. The flight would only “hold a spot” in the system. The same can apply for countries of South America.

Another disadvantage represents the above mentioned CRCO system. Although IFPZ and CRCO are not directly connected and not every IFPZ member uses CRCO service by default, most countries do so. And the system is most likely directed in this manner. However, EUROCONTROL is generally trying to lower fees and make aviation accessible for everyone. And Morocco, via the

comprehensive agreement, committed itself to cooperate with NMOC structures and stand the beliefs, even though it might not be in favor of this trend. The fees, and therefore Moroccan income from them, are likely to be reduced.

At this moment, Moroccan air traffic is fully dependable on international flights. As further described, Europe represents the biggest market in terms of tourism. Therefore, full implementation of everything, that NMOC requires, and making changes to the current system, are reasonable. The question stands, what would happen, if the demand, for any reason, decreased. The threats of today's world, such as unstable political situations, terrorist attacks or racial intolerance could play their roles. Morocco would stay as European-related country, potentially a bit far away from its other partners.

4.5.1.8 Air Traffic Situation and Moroccan Future

Following the rest of the world, air traffic volumes continues to grow. In 2017, Moroccan airports handled 20.36 million passengers and for the first time in the history broke the record of 20 million per a single year. In comparison with the previous year, the growth was almost 12%. According to ONDA, *"Europe is by far the leading market for Moroccan passengers, with 69% of travelers flying on services to the continent in 2017*." [40]

During summer 2018, four new airlines started operating flights to Morocco. Two of them were part of IFPZ – Air Europa (Spain) and Air Malta. Third one was Gulf Air operating from Bahrain, which is also an area cooperating with EUROCONTROL's flight planning and flight plan processing system.

While in 2008, shortly after opening the skies, low-cost carriers constructed 20% of all seat capacity in Moroccan market, that made 1.69 million passengers. Last year, in 2018, there was a 18% growth and now it is 5.55 million. It is then not surprising, that many of the top 12 airliners in Morocco are low cost and therefore the market is even more open since low-cost carriers are more and more favorite amongst European middle class who can afford to fly. Morocco's Top 12 Airliners during summer 2018 can be seen in Figure 11.

Today, France holds the biggest share on the market in terms of passenger seats, which makes 40%. Spain is on the second place with 13% and Belgium occupies the third one with 8.9%. Figure 12 shows the important European flight connections for Moroccan market. With so many flights connected to IFPZ, full centralized flight planning implementation is strongly needed. Following

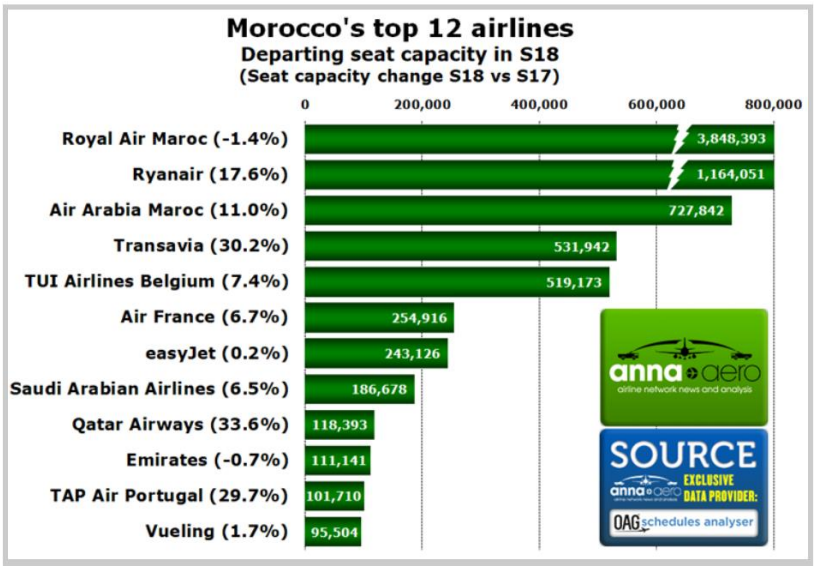

Figure 11: Morocco's Top 12 Airlines in Summer 2018 [40]

Figure 12: Morocco's Flight Connections [40]

places belong Moroccans Middle East (after Europe second largest international) and, also, Sub-Saharan Africa. The number of passengers more than doubled from 2010 and that indicates that Morocco has become an international hub and connecting bridge between Europe and Africa. [40] In 2016, Morocco airport was the 4th most frequent world destination flown from European airports.

At the beginning of 2019, Morocco hit another record. In comparison with 2018, there is more than 10% increase in the number of passengers, 10.66% growth in the amount of movements at Moroccan 17 airports and 10.8% growth in commercial aircraft flying over the Moroccan airspace. [41] In March 2019, ONMT announced, that during summer 2019, eight new airliners are planning on operate to Morocco using 40 new routes. Aircraft will be coming from France, Turkey, Spain, Germany, Greece, Belgium, Austria and Portugal. Some of these routes will be scheduled more than once a week, which contributes to the total sum of 85 new flights per week. Currently, there are 1200 flights in a week. Also, in the middle of April, Volotea started to operate a route between Morocco and Costa del Sol. Ryanair and Greek Aegan airlines also announced new flights to several Moroccan cities during the winter 2019-2020. Morocco is becoming more and more popular destination among tourists, especially the European ones. Right now, it is the best time to join IFPZ and use the benefits of centralized flight planning and flight plan processing. This could potentially open market for new airliners who would be interested in easier, quicker and more effective process of flight planning. [42]

Moreover, the flight expansion is relevant even from the Czech Republic. At the beginning of April one of the biggest low-cost airline companies, Air Arabia, started a new route between Prague and Casablanca. According to ABS Jets, Morocco is a favorite destination, because in comparison with other Arab countries, such as Tunisia or Egypt, there are no major and frequent safety problems such as attacks against tourists or unstable political situation. Due to the high demand, old terminals are reconstructed, and new facilities are built for both business and leisure passengers. [27]

According to ONDA development plan, the Moroccan authorities created a strategy with a clear plan – to make the Casablanca airport an international bridge to the center and West of the African continent, make Marrakech Airport and European hub, and expand and improve many of the 24 airports in Morocco. In 2014, a new long-term strategy Ajwae 2035 was implemented. Its goal is to transport 70 million passengers and manage 515 000 movements by 2035. To meet these objectives, several changes will need to be made and investments places. [43]

In conclusion, Morocco starts benefitting from its location, it is emerging as an important international transport logistical hub and connection between Africa and Europe. Its IFPZ entrance in 2008 represents now a huge benefit and advantage compared to other African countries. Despite the increasing traffic, some businesses still did not use this airspace due to different reasons. They might be afraid to route via African territory, because they do not know what to expect. Many operators fly around and use, for instance, Portuguese airspace instead. Therefore, there is still space for more growth, as globalization continues and throughout the time, even these diligent will start using Casablanca FIR.

4.5.2 Israel

Israel is the most recent IFPZ member. In June 2016, the country signed a comprehensive agreement with EUROCONTROL and the natural progress of this arrangement was the provision of flight plan processing services. On the 22th of June 2017, Israel joined the IFPZ and brought the amount of its members to 43.

4.5.2.1 General Information

The cooperation already started in 2013, when Israel signed an Open Skies contract with the European Union and its member states. This document made the state obliged to harmonize its regulations with the SES concept. After signing a comprehensive agreement with EUROCONTROL, on the 2nd of June 2016, Israel was "*fully implemented into EUROCONTROL's working structures."* [44] and committed to meet all SES objectives. In terms of the Israeli region, the goal was to make the airspace safer and increase its capacity while maintaining smooth air traffic flow. The country was initiated into collaborative flight planning and *"the first steps in the implementation of the applicable FCM objective have been taken with the recent integration of Israel in the IFPZ."* [45] It is expected, that by 2024 a brand-new ATM system will be ready to start fulfilling its function, and with that, the implementation of collaborative flight planning should be fully finished.

According to EUROCONTROL, Israel's entrance to IFPZ should contribute to accurate and consistent flight plans within the whole European air traffic management area [28]. Moreover, gradual improvement of ATC and ATM in the south-east part of the European region is expected.

A descriptive map of the region can be seen in Figures 13 & 14. Israeli FIR, which is Tel-Aviv FIR, is surrounded by flight information regions of 5 other states. These are Lebanon (Beirut FIR), Syria (Damascus FIR), Jordan (Amman FIR), Egypt (Cairo FIR) and Cyprus (Nicosia FIR). Cyprus, as a EUROCONTROL member, also belongs to the IFPS Zone. Jordan cooperates with EUROCONTROL since 2009 via EAD agreement and Egypt signed two bilateral agreements connected to ATFM data exchange (1997) and air navigation charges (2004). With regard to the Israeli neighboring states, the air traffic situation is very complicated. Its relationships, especially with Muslim states, are very bad, and crossing these borders is either impossible or full of obstacles. Operators are then forced to use alternative routes, which take much longer. [27]

Figure 13: Israel on the Map [45]

Figure 14: Tel-Aviv FIR on the Map [46]

4.5.2.2 Situation before 2017

In terms of flight planning itself, no major problems were found. According to ABS Jets, Israeli airspace is small, and there are only a few air routes, that can be used by foreign operators.

Therefore, it is almost impossible for a flight planner to make a mistake while preparing the route. Most of the flights departing from Europe were directed to the airport in Tel Aviv (LLBG). [27] Figure 15 shows a map of the respective area. Important for us are two points – SOLIN and PURLA. All flights coming to Israel end at SOLIN, which is still a part of the Cyprian airspace. Aircraft departing from Israel fly via PURLA.

Figure 15: Flights to/from Israel [27]

In terms of FPL submission, Israel was the most complicated and strict state outside of IFPZ. [21] As today, all FPLs and other associated messages for flights crossing Tel-Aviv FIR were addressed to ATC units within this FIR. Before June 2017, this did not represent any problem for flights departing from IFPZ with the destination aerodrome in Israel – operators sent FPL messages to two IFPS addresses, as stated in the IFPS User's Manual. Accepted flight plans could be then forwarded to all affected ATC units on the way, including Israel.

The process ran quickly, and FPLs were accepted and confirmed by EUROCONTROL, following IFPZ rules. However, different procedures needed to be applied for flights in the opposite direction. Every time an aircraft was to depart from Israel, the operator had to submit FPL through a local airfield reporting office, as stated in the Israeli AIP. The country did not accept IFPS validation process as a satisfactory examination and insisted on checking the plans first. In other words, flight planners were obliged to send the FPL to the final destination (Tel-Aviv), and after the validation, Israel itself submitted the accepted FPL to IFPS. [21] Therefore, it was crucial for the

flight plan to be valid in terms of NM's rules and regulations. IFPUV made the situation much easier. However, if the FPL has not been correct, Israel has sent it to IFPS and the messages has been unsuccessful due to REJ respond, it would have led to a problem. Israel would have sent it back and the whole process would have been repeated. Moreover, if there have been any necessary changes – for instance messages such as DLA (delay) or CHG (change in the content), all these would have been sent to Israel controllers first, who would have distributed them further into IFPS. Mentioned procedures were essential. In case of a direct submission to IFPS, flight planners had to cancel this flight plan and submit it again, according to the Israel's rules.

In terms of ATFCM, Israel was one of the cooperating countries and shared its data with EUROCONTROL. Slot allocation was in place to ensure smooth air traffic flow.

4.5.2.3 Reasons for IFPZ entrance

Israel's reasons for signing a comprehensive agreement with EUROCONTROL, followed by the IFPZ entrance, were undoubtedly connected to the advantages stated in chapter 4.4.2. Becoming a part of the European aviation system meant support in terms of the increasing volume of flights and numbers of passengers between Europe and Israel, which belonged (and still belongs) to one of the main points in Israeli tactical plans. Full cooperation with EUROCONTROL's centralized systems was essential for a safe, well timed and cost-effective development of Israeli ATM.

From the view of IFPZ members, Israel was a desired candidate mainly due to the operational reasons. European airliners frequently utilized this airspace and they had to deal with specific procedures and problems connected to systematical differences. Private pilots experienced significant issues regarding communication with Israeli authorities. In many cases, a delayed feedback in terms of FPL acceptance or rejection occurred, and sometimes, there was no communication from the ATC at all. For that reason, flight planning represented a very precise task allowing no errors. Checking NOTAMs and exploring any irregularities made it even a more demanding task. In addition, inadequate FPL feedback could mean, that the operator had no knowledge of his FPL being rejected until being closer to Tel-Aviv FIR. Logically, without a valid FPL he could not enter, and this caused bottlenecks and further tasks to be performed. System unification should have simplified the whole process and reduce these weaknesses. EUROCONTROL's intention was to make sure, that air traffic with departure/arrival in Israel is going to fit into the needs of the European network.

4.5.2.4 Transition and Changes Made

With Israel's entrance into IFPZ, the responsibility for flight plan processing and distribution was delegated to IFPS system. Pilots and aircraft operators are now responsible for flight plan submission to IFPS; local aerodromes are not in charge anymore. This also applies to any associated messages. The centralized system includes all data necessary for a quick response generation and sends feedback via operational reply message. Unless a valid flight plan is submitted, ATC clearance will not be issued. FPL distribution options were discussed in chapter 4.2.3.

With the effective date of 22nd June 2017, Israel published an AIRAC AIP Supplement. [47] Israel's AIP gained a new part, ENR 1.10 Flight Planning. In this section, included are procedures, restrictions and advisory information on FPL submission and possible changes of a submitted flight plan. [48] Part ENR 1.11 Addressing of Flight Plan messages was changed to comply with new IFPZ members' practices. With the NMOC integration check list being completed, Israel started to use all benefits of IFPS services.

Regarding flight plan processing and distribution, with Israel's entrance to IFPZ, the whole process became much easier and much more efficient. The biggest advantage is simplification in terms of FPL distribution [27]. Since 2017, the former total of 5 different AFTN addresses has been reduced to 2 NM EUROCONTROL addresses, the rest runs automatically via IFPS. Attached is a map of flight from Terceira Island to Tel-Aviv and, also, a flight plan submitted for this flight. Attachment 3 shows FPL from October 2015, which was sent to 2 IFPS addresses (EUCHZMFP, EUCBZMFP) and, also, 3 other addresses stated in the Israeli AIP (LLBGZTZX, LLBGYDYX, LLLNZRZX). LPPOZOZX is a distribution address for Santa Maria Oceanic FIR, because the flight departed from Azores. As seen in the attachment, ACK message was received from EUROCONTROL; Israel did not provide any feedback. It was still possible, that this FPL did not go through and the operator had to deal with consequences later, in front of Tel-Aviv FIR. Attachment 4 shows a flight plan submitted after Israel's entrance to IFPZ. This flight plan can be examined firstly via IFPUV and then submitted to two addresses stated at the top. ACK response will follow and the process is done.

4.5.2.5 Israel's Numbers

Flight plan submission and processing simplification came in the right moment. Israel's air traffic has an increasing trend and according to the statistics, more and more European operators enter Tel-Aviv FIR. During the last six years, the air traffic increase was more than 10% with the average of 900 movements every day. Based on the prognosis, this year, 2019, another increase of 10% is coming.

There is a natural coherence between the increase in traffic and the tourist boom that came to Israel during the last years. Ben Gurion Airport experiences a huge increase of incoming international passengers. The airport's statistics for the period of 2010-2017 can be seen in Figure 16. 2017 brought a record increase of 16% in comparison with the previous year. Figure 17 shows the increase regarding international aircraft movements.

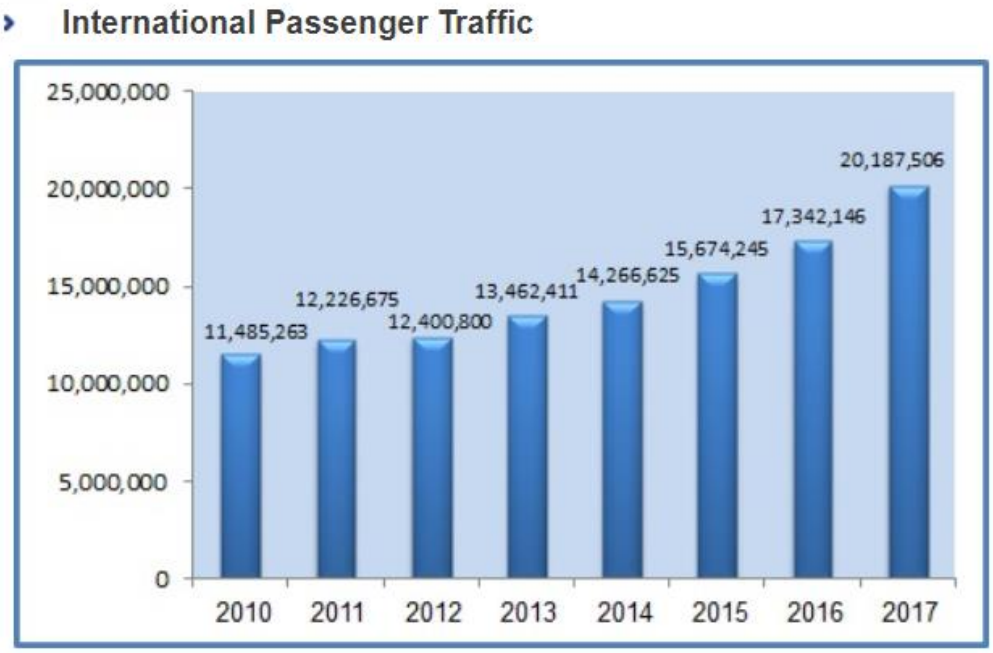

Figure 16: Ben Gurion Airport (Israel), International Passenger Traffic 2010-2017 [49]

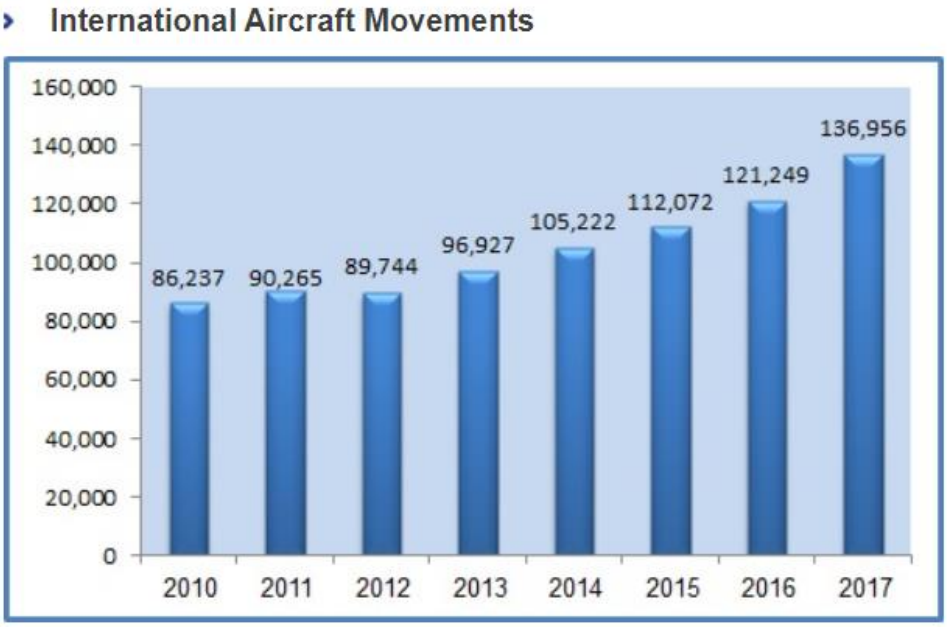

Figure 17: Ben Gurion Airport (Israel), International Aircraft Movements 2010-2017 [49]

The annual report for the Ben Gurion airport (TLV) states, that 99% of all movements in 2018 were international flights. It meant more than 157 movements of aircraft, which carried almost 22.4 million passengers. That is about 10.5% increase for both numbers in comparison with 2017. Airlines, that contributed to these high numbers the most, were Hungarian low-cost airline Wizz Air, British low-cost airline Easy Jet and Ukrainian flag carrier Ukraine International Airlines. The country with the highest volume of passengers was Turkey and its biggest airport Istanbul – Ataturk. As against the previous year, the most frequent destinations were Italy, Poland and France. [50] All countries (and their respective airliners) mentioned, are members of IFPZ.

Considering the last available report from February 2019, the international aircraft traffic increased by almost 5% compared to February 2018. Easy Jet and Wizzair still keep their positions as the most frequent fliers and Istanbul-Ataturk airport stays as the destination with the biggest amount of passengers. Except for Turkey, people are increasingly flying to Austria, Spain and also China. [50]

4.5.2.6 Current Situation, Transition Benefits and Challenges

Unfortunately, greater air traffic and increased volume of passengers go hand in hand with delays. At the end of 2016, Tel-Aviv found itself in the top 20 airports within the NMOC operations area in

terms of delays. However, even though the volume of air traffic increased in 2017, after Israel's integration into EUROCONTROL working structures (including IFPS Zone), delays decreased by 36.2%. At the end of 2017, TLV successfully disappeared from the top 20 list.

Couple of tasks, previously managed by flight planners, were adopted by IFPS. Operators can apply the same rules as they do in Europe, following an identical checklist. The process is easier, quicker and more convenient, because workers do not have to keep in mind different procedures and check everything individually. The workload and stress decreased, and instead of many bureaucratic tasks, their time can be dedicated to the most important thing – efficient flight planning.

The air traffic volumes did not freeze and continue its increase. Therefore, in 2018, the amount of delays also increased again. According to the annual NM Network Operations Report: *„Airport capacity (ATC) remained the main delay cause (72.3% of total ATFM delay) while airport capacity related delay (24.5%) slightly decreased."* [51] Corresponding graphs can be seen in Figure 18. Israel continues its integration to EUROCONTROL's systems and it is expected, that with the state being more and more integrated, air traffic flow will improve. Recent reports also stated, that the information about Israeli FIR are limited as Israel is not participating in the regular NM information reporting process. Supposedly, Tel-Aviv will join the data exchange within this year, 2019, and that will further contibute to the more efficient tactical planning.

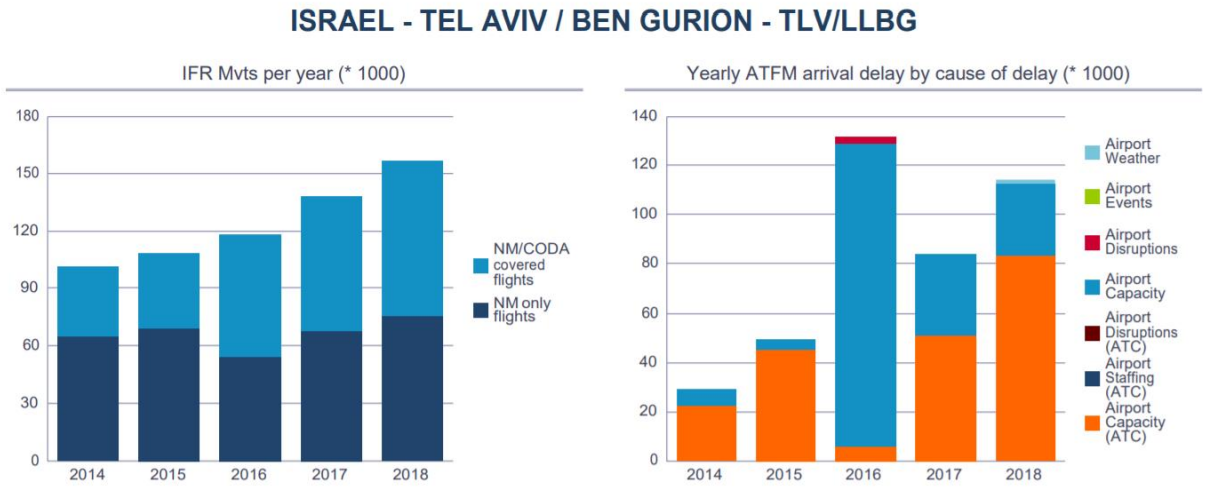

Figure 18: Ben Gurion Airport (Israel), Delays and their causes 2014-2018 [51]

EUROCONTROL stated, that the transition from local flight plan processing system to IFPS was smooth and without problems. They ascribe it to an excellent cooperation between all actors including Civial Aviation Authority of Israel, the Israeli Airports authority and EUROCONTROL's NMOC planning teams.

As previous lines show, ATM partnerships are essential for safe and efficient centralized systems, that benefit everyone included. With full cooperation of member states and sufficient collaboration of adjacent areas, IFPS is already a very strong tool in terms of efficient air traffic flow. However, with more participating states, it can achieve even better results.

5. Extension Analysis

In chapter 5, the thesis looks at two IFPZ-member candidates. After discussion with a few flight planners from the Czech Republic, Turkey, Germany and Great Britain, two countries/FIRs were chosen to be analyzed and examined in terms of a possible IFPZ entrance. These are FIR Minsk (Belarus) and FIR Kaliningrad (Russia). Chosen areas border with the current IFPS Zone; this fact makes them perfect nominees, because their affiliation would have the biggest impact on the whole network and potential further expansion.

Chapter 5 is divided into two subchapters discussing the respective FIRs. At the beginning of each part, regions are generally introduced, and current situation is quantified and clarified using annual reports and existing studies, forecasts and predicted growths. Both candidates are analyzed in terms of economic and operational reasons, technical examination regarding necessary changes in flight planning and flight plan processing, and potential challenges that can occur. Operational reasons are concluded from the interviews with flight planners. Highlighted are benefits of a successful extension and future prognosis.

5.1 FIR Minsk (Belarus)

The first candidate for IFPZ extension is Belarus. This landlocked country in Eastern Europe is one of the EUROCONTROL's partner countries.

5.1.1 General Information

The cooperation between Belarus and EUROCONTROL is legalized by three agreements – EAD, an agreement related to air navigation charges and cooperation between EUROCONTROL and the State Aviation Committee of the Republic of Belarus. For the purposes of this text, the third one is the most important one. The agreement from July 2000 established mutual exchange of data related to ATFM with the goal of increased air traffic efficiency. Connected is the effort to use the maximum of ATS capacity within Minsk FIR. Slot allocation is also included in the arrangement as a European flow management tool. However, flight plan filling and flight plan processing, message exchange and other subsystems that belong to the ATFM procedures, are not unified.

Figures 19 and 20 show, that Belarusian Minsk FIR/UIR borders with Warsaw FIR, Vilnius FIR, Riga FIR, FIRs L'Viv and Kyiv (Ukraine) and the Russian Federation. Apart from the Russian Federation, other mentioned countries are part of the IFPZ. That makes Belarus a great nominee.

Figure 19: Belarus on the Map [52]

Figure 20: Minsk FIR on the Map [53]

5.1.2 Current Situation

Flight planning and flight plan processing within the area of Minsk FIR runs as follows. Operator coming from IFPZ first submits the flight plan to NMOC. Within the centralized system, examination reveals any potential problems that need to be solved. If everything is correct, the initiator gets an ACK message as a response, and FPL can be distributed to all affected FIRs, including Minsk FIR. Respective AFTN addresses are stated in ENR 1.11 of the Belarusian AIP. Generally, it is the responsibility of the first destination in Belarus to locally distribute the FPL to all affected units. Same rules apply for flights departing Belarus and heading towards IFPZ. Belarusian authorities have full trust in the European system and do not insist on being the first ones to check. However, it is still possible that even after a successful validation from IFPS, Minsk FIR, for any reason, declines the flight plan message. The initiator needs to react accordingly and either change or cancel and submit again. Regarding flight plan processing, communication between Belarus and operators is the key. The operator is informed about the FPL's status via message sent through AFTN. However, Belarusian local distribution service is not hundred percent reliable in terms of FPL distribution. [27] In some cases, pilots fly towards Belarus and literally surprise local ATC unit shortly before entering its airspace. As no aircraft can cross the border without a valid flight plan, it is then necessary to communicate to IFPS and let them re-send corresponding data to the respective Belarusian unit.

According to ABS Jets, currently, there are no major issues with FPL submission. The only extra thing, that a flight planner needs to keep in mind, is the fact, that Belarus requires permission for all overflights and landings. [27] Number of the permit is then included in the Field 18 of the flight plan and it is essential for FPL acceptance. Contrary to Morocco, Belarus issues these documents for certain routings. Therefore, any change of the point of entrance or exit means the necessity for a new permit. A flight planner from Turkish Airlines stated, that getting a permission in advance can sometimes represent a problem, because Belarusian authorities do not respond quickly enough. [38]

Among European operators, Minsk FIR is used for flights towards the Russian Federation, China, Kazakhstan, Japan and other Asian countries. (21) While airline overflights in the area happen on the regular basis, direct flights from European cities to Minsk airport are rare. Apart from a couple of exemptions, the monopoly is held by the national flag carrier, Belavia.

5.1.3 Growing Traffic

Even Belarusian airspace notices significant increase in the volumes of air traffic. Statistics covering the number of handled flights between 2006 and 2017 at the Minsk national airport can be seen in Figure 21. The graph comes from the official website of Minsk national airport. In 2017, Belarusian airlines were responsible for nearly 70% of all flights. [54] Within the first half of 2018, Minsk airport handled 1.95 million passengers, that meant 8.7% more than in 2017. Registered were 12 481 aircraft movements of over 1100 air carriers from 90 countries. About 500-1000 aircraft a day enter or leave Belarus' airspace, the number of air routes across this country also grows. [55] Furthermore, in July 2018, Belarus introduced 30-day visa-free period for foreign tourists arriving by plane to Minsk national airport. Included in the visa-free group are also all IFPZ countries. The volume of tourists coming to Minsk has increased by 43% since the new system was implemented. Nearly 40% of all international passengers came from the EU countries. [56] Figure 22 shows EUROCONTROL's air traffic forecast for 2019. According to the STATFOR, Belarus expects an increase of almost 7% compared to 2018. [57]

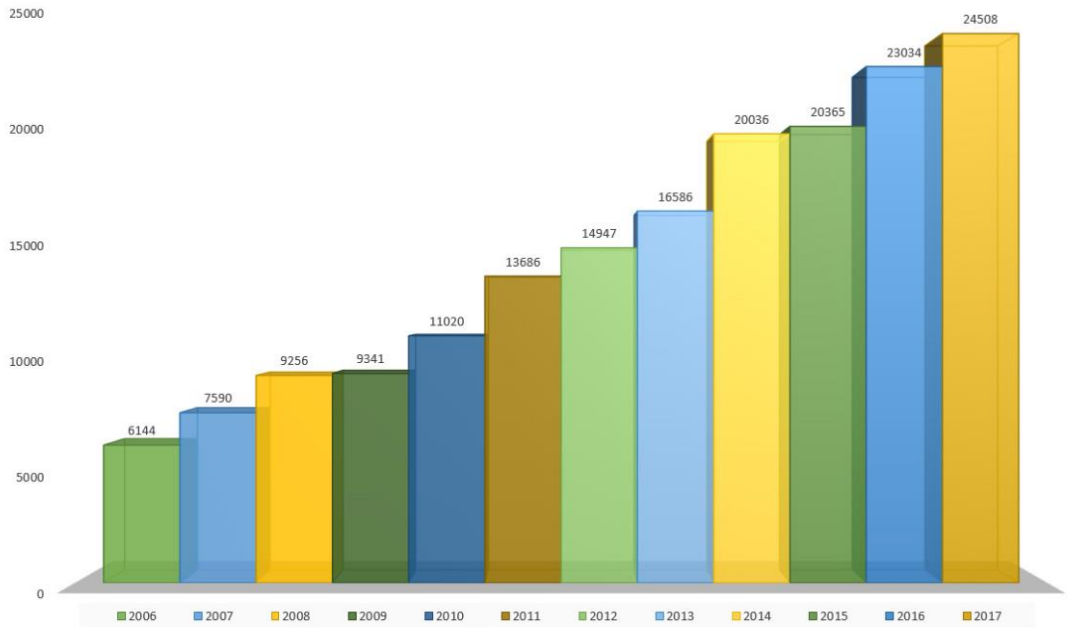

Figure 21: Minsk National Airport: Handled Flights (2006-2017) [54]

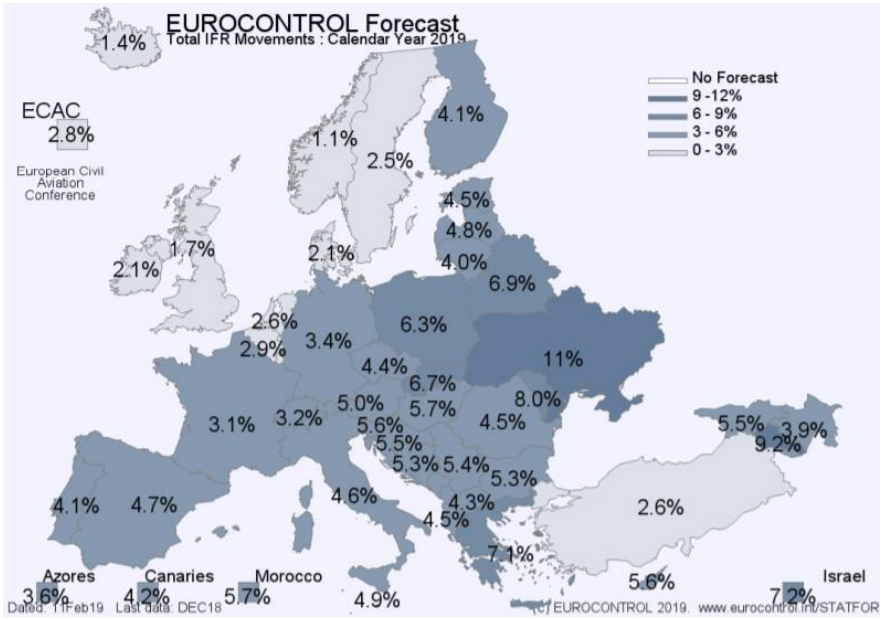

Figure 22: EUROCONTROL Forecast for 2019 [57]

The traffic increase in the last years relates to the fleet expansion of Belavia, the national airline of Belarus, which is based at Minsk airport. Since 2016, Belavia broadened its supply with new flights to Palangia, Lviv, London, Paris, Nice, Rome, Milan, Berlin, Frankfurt, Hanover, Amsterdam, Geneva, Helsinki, Stockholm, Barcelona, Warsaw, Prague, Budapest and Riga. [58] In 2017, the expansion continued and new direct connections to Europe were put on the schedule; this was, for instance, a route between Minsk and Brussels. According to the airport representative, Belarus' strategic location between Europe and CIS represents one of the main reasons for such an increase. [55] This was confirmed especially after the conflict between Russia and Ukraine from 2015, when direct flight connections between the two states disappeared. Currently, Minsk attracts airliners as a major transit point between Kiev and Moscow and this route comprises about a half of all transit flights at Minsk national airport. Moreover, Belavia also operates flights to other Ukrainian airports.

Even this year, the expansion does not stop. At the end of March, Belavia introduced its schedule for summer 2019. Regarding Europe, its plan includes additional flights to many IFPZ destinations such as Barcelona, Riga, Istanbul, Berlin, Budapest, Paris and Tel Aviv. The airline stated, that the decision was made based on the passenger flow analysis and growing demand for flights with Minsk as the departure or destination aerodrome. Authorities also realize, that Minsk is a convenient transit point and they want to use the opportunity and make it an important international

hub. [59] In addition, Belavia is trying to explore new destinations. In May 2019, their first regular flight from Minsk to Tallinn started operating, and, during the summer, new charter flights to Greece and Italy will appear on the schedule. According to the plan, there are 15 new destinations in the summer season and the number of charter flights will exceed 15%.

Belavia is not the only airline expanding the number of flights. Since summer 2018, Finnair started operating from Minsk to Helsinki. Especially passengers travelling between Belarus and North America enjoy the convenience of such a flight. According to ABS Jets, most of the flights towards Russia are routed via Belarus. In these days even more, due to the political situation between Ukraine and Russia, when direct flights are not permitted, and Russian ATC would not allow any plane from Ukrainian traffic to enter its airspace. [27] Numbers do not increase only in the capital, but also at the other airports. The second largest Belarusian airport, Gomel airport, has recently opened a second runway to handle the demand, and expects further developments.

5.1.4 Reasons for IFPZ Entrance

With its geographical location, Belarus represents a great candidate for an IFPZ member; especially considering growing traffic between its airspace and other European countries. During the last ten years, number of flights more than doubled and the trend continues. With these statistics, no errors are allowed. EUROCONTROL, as a European aviation manager, needs to address this demand, because any weakness or simple confusion followed by a delay are strongly undesirable. Belarus is already integrated into NM EUROCONTROL's services in terms of ATFM data exchange but cannot fully use all its benefits. To broaden the partnership and implement the centralized flight plan processing would be a step forward for both Belarus and other affected countries. IFPS represents a much quicker solution as it mostly performs all tasks automatically. With a centralized flight plan processing system, loss of FPLs is almost impossible. Instant communication between the operator and the system contributes to situational awareness. A well-functioning, safe and efficient system is the aim of every country providing air traffic services.

FPL processing uniformity is also a driver for Belarus itself. According to the opinions of flight planners, Minsk FIR loses a lot of European customers due to its dissimilarities. Humans tend to be lazy and they naturally always choose the simplest possible way. Private pilots may not use Belarusian airspace while flying via Europe, because that requires an extra effort and time. Instead, they will submit their flight plan to NM EUROCONTROL and let the system take care of everything for them. Moreover, if they know that a delay in response or improper distribution can

occur, they will not be interested in risking such a situation if a better alternative exists. Belarus might then lose money in terms of permits and overflight fees, further even lose many potential tourists. In these days, international presentation is important and country's integration to centralized structures would undoubtedly have a positive impact.

5.1.5 Integration Analysis

IFPZ integration requires certain changes that would need to be implemented into the current system. Operational transformation is related to developments in terms of technical background, and, also, staff capabilities and training. In the next few lines, Belarusian system is put under closer examination and unavoidable changeovers are revealed. Described is also staff training and prospective costs of the integration.

5.1.5.1 OPERATIONAL AND TECHNICAL ANALYSIS

Operationally, the main change figuring in the list is the delegation of FPL submission and distribution responsibilities. Currently, Belarusian AIP mentions two main message addresses (UMMMZDZX, UMMDYAYX) and one or two more for VFR or mixed flights, depending on the flight with landing at Minsk, Gomel, Brest, Hrodna, Viciebsk or Mahiliou. [60] Associated messages such as DEP, ARR, CHG and DLA are to be sent to the identical addresses. Operators file their flight plans via ARO at the aerodrome of departure. In this case, the simplification is significant with only two EUROCONTROL addresses (EUCHZMFP a EUCBZMFP) and possibility to file directly via IFPS.

Times for FPL submission would need to be adjusted. For a non-scheduled international flight with or without landing in Belarus, FIR Minsk requires the FPL 3 hours before EOBT (identical to IFPS rules). However, there is a possible contract with the provider of air navigational services in Belarus, BELAERONAVIGATSIA SOE, regarding non-scheduled flights, that lowers this period to 60 minutes. For a system of EUROCONTROL's size, no such exemptions could be allowed. In terms of the RPL system, Belarus applies stricter rules and their mitigation should have only positive impact. The list of repetitive flights both landing and overflying must be submitted at least 14 days in advance. For IFPS, when considering all possible scenarios, the maximum time is 8 days in advance.

Suggested change would be either the cancelation of current permits or linking them to the flight planning itself. A modification, in which overflight and landing permits are implemented into the FPL and not dealt with separately, would represent a huge time-saver. Belarusian CAA connected to IFPS would be able to evaluate the request and send ACK only when the flight receives authorization. Fees collection could be made via CRCO or using a similar system. Simplification in this manner would satisfy both sides and make the situation easier for flight planners.

All ATS systems used by Belarus are fully compatible with EUROCONTROL and ICAO regulations. The country aims to reach the highest technological level possible. However, in terms of centralized flight planning, according to the last ICAO ASBU (Aviation System Block Upgrades) monitoring report from 2017, the processing of FPL and ACH messages, is still manual. [61] With manual processing, the possibility of an error increases and it brakes system's efficiency. Delegation of these tasks to the automated system within NM would be a huge step forward. Processing of AFP messages is also manual. AFPs are used for instance in the case of change of flight rules, change of route or trajectory (via ADEXP) or for potentially missing flight plans, where ICAO format can be used. Independently of a possible IFPZ entrance, the plan for automated message processing has been on the table for a couple of years and it was postponed several times. The current due date is the end of 2019. [61]

Technologically, IFPS implementation does not represent any further problems. EUROCONTROL fully supports its countries and airspace users with necessary software and accesses. Most of the framework is available online, and for any external services, basic technological equipment is enough. Belarus does not use ADEXP format, and even though IFPS is able to accept messages in ICAO format and transform them for further distribution within IFPZ, ADEXP implementation would be crucial. Considering the level of technology, Belarus is fully capable of joining IFPZ.

5.1.5.2 EXPECTED DURATION

Duration of the checklist's completion and possible start of IFPS services provision varies. However, it can be a relatively quick process, depending on the cooperation of both sides.

Based on the accessible information, data transfer together with pre-validation tests can take from 2 to 5 months. It is assumed, that Belarus has already undergone similar process due to agreements related to ATFM data exchange and EAD services. Therefore, we will work with the minimum completion time – 2 months. Tasks related to AIC distribution, updates of IFPS User's

Manual and integration into NOP will be almost immediate, as there are no major changes to be done in terms of air traffic management. AIP Belarus is generally well-arranged and very easy to use. Minor changes would need to be made, most likely within ENR 1.10 and ENR 1.11, with the aim to explain the IFPS procedures and update applicable rules described in 5.1.5.1.

Regarding the training, EUROCONTROL provides a wide variety of different courses connected to all its systems and general air traffic control and management topics. For the purposes of this analysis, we will take into consideration only those, that are unavoidable. Currently, offered are 3 classrooms courses for 7 days in total. [62] These are IFPS, NOP and CIAO. Starting from September 2019, the plan will be changed. There are 2 new courses prepared for flight planners, aircraft operators and ARO's staff. Courses and their hour donations can be seen in Table 3. Flight Planning Advanced represents a general introduction to IFPS, both in terms of theory and practice. The course takes 2 days. Flight Planning and Flight Management course includes IFPS in connection with NOP and CIAO; its duration is 5 days. Both classroom trainings are set into the NMOC building in Brussels. A recommended prerequisite is an e-learning course IFPS and Flight Planning and, also, self-study of a guide to NM flight plans. As it can be calculated from Table 3, compulsory IFPS training takes about 66 hours (circa 9 days).

Table 3: IFPS Training for Belarus

IFPS Training: Respective Hours		
COURSE TYPE	**COURSE NAME**	**DURATION [hours]**
E-Learning	IFPS and Flight Planning	6
Guide	NMO FPL	4 (estimated)
Classroom	Flight Planning Advanced	16
	Flight Planning and Flight Plan Management	40

As the training can run simultaneously with the system's initial testing phases and no other major adjustments need to be done, the expected duration of Belarus' IFPS integration is 2 months. To support the statement and, also, to compare with other non-European states, Azerbaijan

completed its IFPZ transition by 40 days since the agreement with EUROCONTROL was signed. [63]

5.1.5.3 FINANCIAL ANALYSIS

As the centralized flight plan processing is covered by EUROCONTROL and the organization technologically supports its member states and countries of IFPZ, any costs related to system update are omitted. Financial plans are made individually and depend on various inputs. Software is provided free of charge; not only for the states themselves, but also for any registered airspace users, who will make use of it while planning their flights.

Estimated costs related to the IFPZ integration comprise mainly from staff training. For member states' competent authorities and certified airspace users, the above-mentioned modules are free of charge as they are paid from the EUROCONTROL work program. Prospective costs for NMOC in terms of providing the space, lecturer and systems used – and therefore a charge, that is applicable to any other party – is 320 EUR per one day of training. [62] As stated, direct training costs are covered by the organization, however, everything else would be the responsibility of Belarus. Related costs include employee's standard hourly rates, and, also, travel and accommodation expenses. Classroom courses take place in the NMOC in Brussels. According to the Training Zone Calendar, the courses are taught every month except for the summer season (July, August) and the spaces are limited. Flight Planning and Flight Plan Management does not follow Flight Planning Advanced on a timeline. However, it is assumed, that EUROCONTROL would create a special individual schedule. That way, employees could spend 7 days in Brussels at once. Estimated costs are shown in Table 4. Return air tickets from Minsk to Brussels can be found approximately between 199 and 340 EUR, with Belarusian airline Belavia or German Lufthansa. There is a negotiated taxi service from the airport to NMOC included in the transportation within Brussels. Regarding the accommodation, countries' delegates can use negotiated preferential rates at certain hotels. The price ranges from 60-80EUR per night with the discount applied. [64] Total costs for the Brussel's Training are therefore 460-1160 EUR per person.

Table 4: IFPS Training for Belarus: Related Costs

Brussels Training's Related Costs		
TRANSPORTATION	Return Ticket	200-340 EUR
	Transportation within Brussels	100 EUR
ACCOMMODATION	Price per Night	60-80 EUR
	Number of nights	6-9
	Total for Accommodation	360-720 EUR

The second part of the related costs create the hourly rates of employees. Concluded from Table 3, training take 66 hours per person. According to their website, BELAERONAVIGATSIA SOE employs around 1800 people, about tenth of the staff would need the IFPS training. [65] That makes the total of 11 880 hourly rates extra.

5.1.6 Additional Transition Benefits

Being a part of EUROCONTROL's structures guarantees, that Belarus would permanently stand at the forefront of technological field. As NM keeps developing, its countries need to do so as well. This expansion relates to infrastructure, meaning working on current and new routes and sectors, as well as to increased performance and greater interfaces between other airspaces. Exchange of experience, and convergence of the systems and training plans, represent an enormous advantage that Belarus could benefit from. Increased cooperation European-wise would certainly help the country to move quicker.

Belarus does not host many other airlines than its national flag carrier, Belavia. Easier flight planning and adherence to certain standards could help opening the marker for low-cost business. Under current circumstances, it is not profitable for low-cost airliners to fly to Belarus. Neighboring states are used for connections with countries of the EU and the profit of Minsk airport is therefore decreased. After the implementation of visa-free regime in 2017, the volume of passengers coming via Minsk national airport significantly increased and the international demand is as high as ever. Opening the market to international carriers and, also, extending the visa-free rule to other entrance points, would undoubtedly cause tourism boom.

5.1.7 Challenges and potential disadvantages

The biggest challenge of the transition is the political system of Belarus. The country is governed by a president with almost unlimited power, and the state is frequently referred to as the last European dictatorship. Even though some of the decisions regarding air traffic infrastructure moved the country forward, the politics is generally very closed to other states. Broadening cooperation with neighbors would mean a continuous loss of absolute power, that the president holds. Despite this fact, centralized flight planning is essential for Belarusian air transportation and a couple of small steps were already taken that moved the country closer to the European aviation system. The benefits of IFPZ could be strong enough to break through the political barrier and activate the transition.

Opening market for low-cost carriers by simplifying flight plan processing and adjusting to IFPS, could mean a threat for the national airline, Belavia. According to the management of Minsk airport, the low-cost is not enough for Belarussian standard. The country does not identify itself with extra fees for checked bags, seats, etc. [66] In other words, in Belarus, aviation still holds the label of “luxurious” transportation and the standards should be kept on high levels. However, it seems, that Belarus is not interested in competition from international carriers. There are not many flights arriving in Minsk except for the ones from Belavia; and, also, the recent visa-free regime applies only for passengers coming via Minsk airport. Tourists are then artificially forced to fly with the national flag carrier.

5.2 FIR Kaliningrad (Russia)

Kaliningrad is a Russian region, that lies practically in the middle of the IFPS Zone. Mainly due to its location, it was chosen as the second candidate country.

5.2.1 General Introduction

Kaliningrad is an exclave of the Russian Federation and, at the same time, the most western and the smallest region of the country. Respective maps can be seen in Figures 23 and 24. The Russian Federation is one of the partner countries of EUROCONTROL. Their agreement from

2007 opened a framework for mutual collaboration in the field of Air Navigation. [67] Although Kaliningrad is not physically connected to the Russian Federation and has its own governmental authorities, it is under its regime and follows all its rules.

Figure 18 shows, that Kaliningrad FIR borders Warsaw FIR, Vilnius FIR and Sweden FIR; Poland, Lithuania and Sweden are members of IFPZ. The Russian Federation has its own flight planning and flight plan processing system with different rules and requirements from the European one. Nevertheless, Kaliningrad FIR belongs to FPM copy area, as seen in Figure 6.

Figure 23: Russian Federation on the map [68]

Figure 24: FIR Kaliningrad on the Map [69]

5.2.2 The Russian System

To fully comprehend the functioning of Kaliningrad FIR and to be able to analyze its IFPZ potential, it is necessary to understand the Russian processes. Because the Russian Federation uses an individual system, the next few lines give a brief description of the ATM structure in the Russian aviation and areas under its influence.

The responsibility for air traffic provision stands on the Unified Air Traffic Management (EU ATM). Within the Russian regions and involved areas, there are 28 ATM centers. These include the main center, 7 zonal and 20 district centers. [70] EU ATM has its headquarters in the capital, Moscow,

and one of its main tasks is, beside issuing permits for international flights, ATFCM. Operators, who want to fly to/via Russian areas, are required to submit their FPL (in Russian “Application”) to the Main Air Traffic Management Center (MATMC) and to another – usually one – unit depending on the destination aerodrome. Following process runs identically to IFPS validation; FPL is analyzed and compared against restrictions on the route. An automated system either accepts or rejects the FPL message, and, if necessary and possible, manual changes are made. In addition, the Russian Federation uses the concept of state priorities and applies special procedures for different countries and different routes [70]. The airspace is divided into 2 types, one with the need of permits, and, areas with less traffic, that operators can use without prior arrangements. However, even in the second case, the pilot is still supposed to advise EU ATM of his entrance. Again, the concept of state priorities is used and therefore, one cannot plan very easily. EU ATM is not directly connected to ATC.

5.2.3 Current Situation

For European operators, FIR Kaliningrad represents a very restricted airspace. Due to military operations, there are only a few civilian routes that can be used and even those are frequently unavailable. Kaliningrad’s sky vectors can be seen in Figure 25. Only a small number of airlines or private aircraft use this airspace. [69]

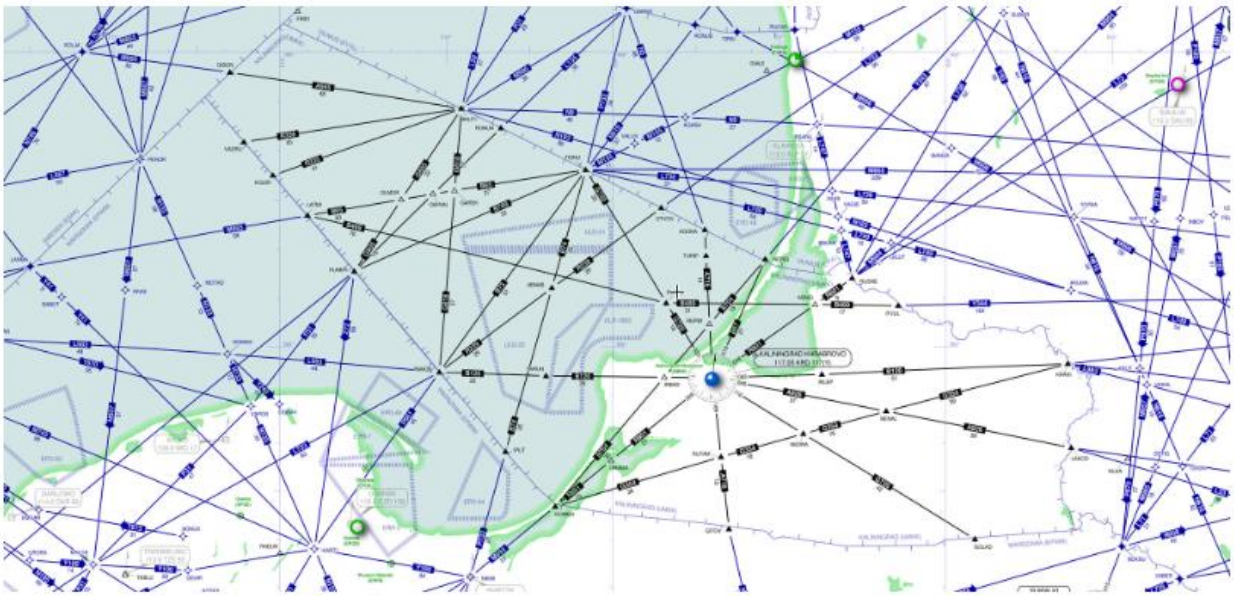

Figure 25: Airways of FIR Kaliningrad [69]

As discussed in 5.2.2, the Russian Federation does not participate in the European aviation system, and therefore, when planning a flight from IFPZ via/to Kaliningrad, operators cannot rely on EUROCONTROL in terms of a suitable and satisfying routing. [27] Flight planners need to make use of Russian sources and, also, regularly check NOTAMS informing about any irregularities. Moreover, as the Russian Federation requires landing and overflight permits for all flights, the same applies to Kaliningrad. Permit issuance is the responsibility of the main ATM center and CAA located in Moscow. Applications are filled in online and the request must be to be obtained from 14 business days to 72 hours before the flight, depending on the type of operation. Granted permit is only valid from the day of operation till 48 hours after ETA. [71] For international flights, FPL must be submitted 3 hours prior to departure.

Planning via Kaliningrad FIR, if available for flights, adds many extra tasks to the job of a planner. In comparison with Belarus, the situation is easier in terms of FPL modifications. The FPL schedule, entry and exit points and, also the route, can be changed within the same permit. However, even though the lead time for processing the application is 20 minutes by law [70], delays occur, and sometimes, the process becomes longer than expected. In all cases, the permit must be issued at least 24 hours before the departure. [71] The system seems long and tedious. However, according to ABS Jets, operators frequently use the permit-free exception routes further from the coast, that are located above neutral airspace. [27] With those, one usually does not experience any major problems. Moving to FPL distribution, flight plans for routes between IFPZ and Kaliningrad are sent to NM EUROCONTROL and, also, AFTN addresses stated in the Russian AIP. NM EUROCONTROL does not forward FPLs to Kaliningrad FIR automatically, and full distribution is the responsibility of the operators.

According to Ota Hajzler, FIR Kaliningrad tends to be a problem for flights to Finland. FPLs need to be submitted to both, IFPS and Russian FPL processing system, and a permit is required in advance. Due to frequent complications, it is much easier to find a route around the area, although alternative routes are not direct. [21] Planning department of Turkish airlines, for instance, does not use Kaliningrad's area in general. It is not worth for them to spend time with inefficient planning for such a small portion of the flight when there exists another alternative. [38]

5.2.4 Traffic over Kaliningrad

Kaliningrad FIR lies in the middle of the European Union and, therefore, it is frequently used for flights connecting northern Europe with the southern countries. The increase in the European air traffic logically influences growing demand for overflying Kaliningrad FIR.

There are not many direct routes between European cities and Kaliningrad. According to the airport website, more than 85% of all flights departing/arriving to Khrabrovo airport (KGD) operate to/from other Russian airports, mostly in Moscow and St. Petersburg. [72] The biggest number of international connections weekly is held by Belavia with 16 flights to Minsk, and AZUR Air with 8 flights to Antalya. Direct connections to Warsaw are operated by LOT airlines and destination Riga can be flown with Air Baltic. KLM, Air France, Alitalia and China Eastern Airlines operate codeshare flights on the route Kaliningrad-Moscow. However, local bodies are ready for more international flights and passengers. Khrabrovo airport was recently re-designed and reconstructed for 3.5 million passengers per year. Also, in 2018, the Russian exclave hosted 4 matches of the FIFA World Cup and therefore, lots of European fans arrived using added short-term international flights.

In terms of airlines overflying the territory, numbers are very different. Contrary to departures and arrivals, most of the aircraft using the airspace without landing, are international. Convenient location and the possibility of direct flights is the main driver for such decisions. However, in this small non-European area, foreign operators need to follow rules and procedures of the Russian system and sometimes they have a disadvantageous position. For instance, Aeroflot uses FIR Kaliningrad for flights to western Europe and has a preference before other international airliners.

Statistics and forecasts are accessible only for the whole Russian Federation. In 2018, transit flights over the whole Russian territory created the total of 18%. Out of the 82% of take-offs and landings, more than a half was international. The volume of flights and their intensity grows by 7-10% every year. [70]

5.2.5 Reasons for IFPZ entrance

Even though according to some opinions, Kaliningrad FIR is highly unlikely to join the IFPS Zone, there are some strong arguments supportive of its entrance. To begin with, we will look at the European point of view, where the main reason for Kaliningrad’s integration is its location in the

middle of IFPZ. Considering the significant simplification for several European operators and more efficient planning enabling the increase in the capacity of the European airspace, FIR Kaliningrad is practically a perfect nominee. The Russian Federation is an important partner for all NEFAB (North European FAB) members, because all of them share their borders with it. A big amount of flights between Western Europe and Russia fly via the NEFAB airspace. When looking at Estonian FIR Tallinn and, also, Lithuania FIR Riga, almost half of all the flights cross Russian border. Strengthening cooperation is needed in terms of route network and coordination around borders; unified flight plan processing would be a great first step.

Benefits from this transition would not have to stay only in the aviation world, for the Russian Federation, it could also be a good opportunity how to carefully open cooperation with the European Union. According to Solomon Israilewitsch Ginsburg, a Russian politician, historian and speaker of the regional elite, that supports Russian cooperating with Western Europe [73], Kaliningrad represents an opportunity for partnership between the European Union and Russian Federation. He says, that even though there are undoubtedly some fields, in which the cooperation is not possible due to significantly different opinions and general politics, somewhere else, small steps could be made to start a successful and mutually beneficial synergy. In his opinion, both sides should concentrate on the business-oriented aims, rather than old fights. Ginsburg proposes moving all departments dealing with EU cooperation to Kaliningrad and transforming it into the center for international negotiations. Furthermore, his plan includes tax concessions for EU companies and, also, visa free travels both ways. [74] As far as this might seem unrealistic, the idea of Kaliningrad being the bridge between Europe and Russia is not new. A region, that is surrounded by the EU is truly an opportunity for cooperation. Ten to fifteen years ago, KD Avia, the first Russian low-cost company, tried to make Kaliningrad a traffic hub for Russian flights to couple of European cities (Prague was one of these). [75] Unfortunately, it went bankrupt. According to Ginsburg, among Russian nationals, there is a huge demand for such a place, because currently, on their ways to Europe, Russian passengers are forced to fly via Moscow and St Petersburg, which might be inconvenient for some regions. [74] The entrance to IFPZ and simplifying the whole process for European airliners, could be the first step for resumption. Simply, both sides should make the effort towards deeper cooperation.

5.2.6 Integration Analysis

Kaliningrad FIR follows rules and regulations of the Russian Federation. As it represents a system completely separated from the European structure, IFPZ integration would need several adjustments.

5.2.6.1 OPERATIONAL AND TECHNICAL ANALYSIS

The Russian system of flight plan submission, processing and distribution is generally very similar to the one used by EUROCONTROL. FPLs for international flights must be submitted not earlier than 120 hours before EOBT and the latest 3 hours prior the flight. Operators can file directly to the system and are responsible for complete addressing of all messages. Distribution addresses for all departing/landing and transit flights are stated in the AIP – all messages are sent to MATMC (UUUWZDZX) and ATFM en-route units dependent on the flight direction. The en-route units correspond with 7 zonal centers mentioned in 5.2.2. Kaliningrad, for instance, belongs to the western regions, together with St. Petersburg or Murmansk. Regarding the ATC-operator communication, ACK and REJ messages are used. The processing is mostly automatic, if needed, manual changes are made. Permits are required for several routes and must be obtained in advance. As one can see, the system works almost identically to IFPS and not many things would need to be adjusted or changed in this manner. The difference is in the provider of the system, the Russian Federation has its own state unit working on its own. The transition of Kaliningrad could be very easy. For flights in the area, operators would simply file to IFPS instead of the Russian system, and automatic distribution to local ATC unit would follow. As described in the first paragraph, submission times for the Russian and European systems are identical, and in any case, Russian operators heading to Kaliningrad from any direction always enter IFPZ even now. While it does not represent any change for them, it would mean a huge step for European airliners.

As mentioned above, Russian ATM is fully separated from NM EUROCONTROL and does not use completely the same formats as Europe. For FIR Kaliningrad, it would be necessary to adjust to some of these structures. Currently, both Russian and European system use for their FPLs and associated messages ICAO format and the AFTN network. The difference comes, as by the Belarusian example, with IFPS having an additional format, ADEXP. Although many messages coming to IFPS are in ICAO format and the system is capable of converting them into ADEXP without any problems, ADEXP is crucial for functioning within the IFPZ. ADEXP is used within NM B2B (Business to Business) and, also, in the IFDP (FPLs database). Considering the size and

volumes of ATM center in Kaliningrad, the implementation should be quick and easy. EUROCONTROL offers voluminous guidelines, practical trainings and further support. The Russian Federation has already considered implementation of ADEXP for its system, however, according to the last ICAO ASBU Monitoring Report, no concrete plan has been made and the topic should be further discussed only after 2020. [61]

The question of permits could be solved in the same manner as described in the example of Belarus – implementation of permit requests to the flight plan itself. However, it is only a recommendation. The system of overflight permits could stay even with Kaliningrad's integration into IFPZ, as it happened with Morocco.

Another thing to consider is the European use of AFP messages. Russian rules define the communication and interaction between the air traffic planning departments differently and even though it would make the Russian system more accessible to other airspaces, there is currently no plan for its implementation. FIR Kaliningrad would have to be the forerunner and testing region, whose experience might lead to further implementation to other Russian parts.

Within the European aviation system, a heavily discussed topic connected to flight planning, is the implementation of FRA concept. Russia recently started investigating the possibility of implementing concepts FUA and FRA. In February 2019, national representatives and experts from various fields such as ATC, ATM and military, gathered to start discussing future proposals of such actions. Included will be a study of the concept's principals, with the use of ICAO and, also, EUROCONTROL's analysis. The plan is to look at the current ATM system in Russia, its airspace organization, airspace planning, ATS and military interaction, and compare them against the concept's requirements. [76] The implementation of FUA and FRA will move Kaliningrad closer to the EUROCONTROL's concept and fill in the gap in the middle of Europe.

5.2.6.2 EXPECTED DURATION

Considering the fact, that FIR Kaliningrad is not included in any of the EUROCONTROL's structures, most of its corridors are used by military and the Russian Federation does not apply FUA concept, we assume, that the airspace has not been explored in terms of possible capacity expansion. Therefore, the pre-validation process and testing phases would presumably take the maximum time – 5 months.

IFPS training is going to be similar to the Belarus' example, however, some courses will need to be added to the list. Because Russia is using its own system and it is unlikely that any of their staff had a possibility to experience the European aviation system in any way, additional e-learning courses are recommended. Apart from the introductory course IFPS and Flight Planning (6 hours), there are also ATFCM Basic (4 hours) and ATFCM Messages (2 hours). Beneficial would be the familiarization with the NMO FPL guide (estimated time 4 hours). Regarding the classroom training, identically to Belarus, two IFPS courses are necessary – Flight Planning Advanced and Flight Planning and Flight Management. [62] Courses and their respective hours can be seen in Table 5. The expected duration of the required IFPS training for Kaliningrad is 72 hours.

Table 5: IFPS Training for Kaliningrad

Training's hours per person		
COURSE TYPE	**COURSE NAME**	**DURATION [hours]**
E-Learning	IFPS and Flight Planning	6
	ATFCM Basic	4
	ATFCM Messages	2
Guide	NMO FPL	4 (estimated)
Classroom	Flight Planning Advanced	16
	Flight Planning and Flight Plan Management	40

In terms of changes in the aeronautical publications, the Russian AIP would need to be updated with new procedures. A new paragraph referring to Kaliningrad and IFPS is recommended for ENR 1.10. In addition, a modification of distribution addresses within ENR 1.11. Another possibility would be to insert of a special part related to Kaliningrad as a region within IFPZ.

Identically to Belarus, pre-validation process, training and updating aeronautical publications can run simultaneously. Therefore, the expected time for Kaliningrad's IFPS implementation is set to 5 months.

5.2.6.3 TRAINING AND FINANCIAL ANALYSIS

In terms of finances, Russian system is very advanced and in terms of technical equipment, there are no major changes and transformations that would need to be made. The key is to unify the system and make use of the same formats, rules and procedures.

Regarding the training, the same analysis as in the case of Belarus applies. Costs related to the classroom courses in Belgium are shown in Table 6. The fastest return ticket Kaliningrad-Brussels ranges from 230 to 540 EUR with Air Baltic and one stop in Riga. Other items stay the same. Total costs for the classroom training in the case of Kaliningrad are therefore 690-1360 EUR per person.

Table 6: IFPS Training for Kaliningrad: Related Costs

Brussels Training's Related Costs		
TRANSPORTATION	Return Ticket	230-540 EUR
	Transportation within Brussels	100 EUR
ACCOMMODATION	Price per Night	60-80 EUR
	Number of nights	6-9
	Total for Accommodation	360-720 EUR

As summarized from Table 5, the complete IFPS training takes 72 hours per person. With the assumption of approximately 100 staff (including Kaliningrad's workers and, also, MATMC), the additional expenses would be 7200 hourly rates.

The EUROCONTROL Training Zone Brochure states many more advanced courses, that could deepen the knowledge and help the employees to adjust. For the purposes of this text, the analysis deals only with the most necessary trainings for a successful IFPS implementation. As mentioned before, the classroom courses are offered by EUROCONTROL every month and E-learning courses can be passed from Kaliningrad. However, as well as with Belarus, the analysis is based on the accessible information from the internet and to get the general idea on how the process works. NMOC would presumably create an individual plan and schedule to train as many staff as possible within the shortest time possible.

5.2.7 Additional Transition Benefits

From the EUROCONTROL's point of view, the benefits are more than obvious, and they are basically identical to the reasons stated in 5.2.5. Kaliningrad's entrance to IFPZ would fill the current hole in the middle of the European aviation system and enable airliners to fully operate within the area. It would lead to increasing the SES capacity, which is strongly desired.

For Kaliningrad, certain advantages appear too. Possibly, Khabrovo airport could open the market for more international airliners, bringing bigger volumes of people and possibly attracting more international investors. A huge advantage represents EUROCONTROL's training and technical support, business development would be unavoidable. Kaliningrad would move closer to Europe as it technically is a part of Europe in some ways. Furthermore, the Russian Federation could use Kaliningrad oblast as an EU-cooperation experiment. Local authorities are already investigating FUA and FRA concepts and they are on their way to get closer to Europe. Technically, it would be a good start for Russia to enter a centralized flight planning and flight plan processing system, that is already working in Europe, and investigate the nature of the cooperation. If it suits them, the partnership could be deepened even in for other regions. Full support from NM EUROCONTROL would be provided and used for own development. Even though the situation, in which the whole Russian Federation is a part of EUROCONTROL's aviation structures, is currently a very unlikely event, smaller steps could slowly intensify the EU-Russian collaboration and open new ideas in terms of possible improvements.

5.2.8 Challenges and Disadvantages

Last paragraphs were devoted to the advantages of this transition, and now it might seem, that there is no stop sign for Kaliningrad's entrance. Unfortunately, challenges in this case are not small. The biggest problem is the current political situation and seemingly very undesired cooperation between EU and Russia. Some people claim, that FIR Kaliningrad is, in a certain way, an ongoing tradition of the Cold War. This statement refers to limitations for international AOs flying to East Germany, when Soviet authorities limited airspace corridors only to three possible routes and applied strict rules. Permits were also put in place. [69] For the Russian Federation, FIR Kaliningrad is a very strategic area and with any concession, Russia somehow loses the privilege of having such a location under its control. Moreover, if FIR Kaliningrad changed its system of flight planning and flight plan processing, it would be different from the rest of Russia

using the former system. As mentioned above, domestic flights represent the majority of all flights to and from Kaliningrad. And even though there are many flights overflying the territory and EUROCONTROL would not affect these flights necessarily, it would be the main argument on the Russian side. On the other hand, this situation could be easily solved by having two systems in one region, which would only support the idea of a Europe-Russia bridge. In case of Kaliningrad not wanting to enter IFPZ, the system could be also split to different rules for flights arriving to Kaliningrad and only overflying the area. In all cases, any IFPZ expansion, either full or partial, is desired.

6 Conclusion

Over the last decades, Europe has experienced an enormous increase in air traffic volumes. Globalization, competition causing lower air fares and growing tourism contributed to higher demand for flights. At the same time, due to fragmented airspace, several political conflicts and various regulations coming into force, operators are compelled to leave their usual corridors and use alternative ways instead. The airspace capacity has shrunk and finding optimal plannable routes became very challenging. In 2018, delays rose quicker than ever, and some areas collapsed in terms of providing an efficient local ATFCM. According to the forecasts, increasing trend will continue. It is expected, that the total 11.7 million flights will be brought into the European airspace in 2020. The question is, how to react to the future numbers and what can be done to handle them successfully. Current performance needs to be at least kept, but rather improved; the capacity increase is essential. Expansion of the Integrated Initial Flight Plan Processing system could bring the solution.

The thesis had three main objectives. The first one was to explain the role of IFPS and other considerable systems with regards to the EUROCONTROL Network Manager and show their importance within the European aviation system. IFPZ analysis was the task of the second part. Basic functioning, pros and cons of such a system, necessary entrance requirements and integration process were some of the topics discussed. To support the statements and provide relevant examples, two member-states were chosen to be put under examination; these were Morocco and Israel. Last and the most important objective of this text was to analyze two neighboring FIRs as potential nominees for new IFPZ members.

To fully understand the importance of the European structure, the history of air traffic control and system integration is briefly discussed in the first parts of Chapter 3, with references to other relevant sources. The experience from the past can be used to address the current situation. After the delay boom during the 1980s, various countries started to protect their airspace and put more restrictions locally. That led to even more delays. Soon it was realized, that only the establishment of a centralized system and close cooperation lay the foundations for capacity expansion. Today, EUROCONTROL has the same objective as individual states had in the past – to cope with the rest of the world. However, compared to the history, there is already a well-functioning system developed, described in the rest of the chapter. At the beginning, CFMU was just an unorganized set of regional units that were using capacity of the airspace in a very static way. NMOC, today, represents a sophisticated and developed communication hub fully managing 43 states not only

from Europe. Such a system is unique in the world. Now, the task is to persuade other states, that the general integration is the best solution.

To optimize the network, inputs represented by flight data are necessary. IFPS, European flight plan processing system, provides an excellent service of automatic validation, distribution and update on FPLs within its area of operation, called the IFPS Zone. Chapter 4 is aimed on the nature of these centralized processes and highlights the beneficial differences compared to individual systems. Among the most important advantages, there are FPL consistency, ensuring correctness and automatic distribution. The advantages are not applicable only to NM, others benefit too. All data are shared with airspace users and airports, and for operators, the flight planning procedures are much easier. An excellent system feedback increases situational awareness that contributes to both, safety and efficiency of air traffic. All affected actors, air traffic controllers and aircraft operators, have quick access to the current situation, which supports them in further planning. Predictions are made, and decisions follow the dynamic airspace changes. Due to various international agreements, EUROCONTROL shares flight plan data with all neighboring airspaces. However, it is not enough. Flight plans coming from the outside are not precise and updates can be delayed. This uncertainty significantly lowers the capacity airspace as it lowers the ability to predict. Therefore, closer cooperation and consistency is crucial. To support these statements and show the difference before and after IFPZ entrance, two non-European members, Morocco and Israel, are put under examination in the second part of Chapter 4. With the help of flight planning departments of five European airliners, conclusions are made about the transitional benefits in terms of ATFCM, flight planning and desired traffic increase. In addition, while studying Morocco, interesting inconsistencies and lack of harmonization within IFPZ was discovered. These created confusion among flight planners and reduced the benefits of centralized system. After discussion with EUROCONTROL, solutions were offered in terms of better information flow and updating aeronautical information publication.

The last part of the thesis covered IFPZ extension analysis. Firstly, two neighboring FIRs were chosen to be analyzed – Kaliningrad FIR (The Russian Federation) and Minsk FIR (Belarus). These, according to the flight planners interviewed, would have the biggest impact on the European network. Below is the summary of the most important findings.

MINSK FIR

The airspace is frequently used for flights to the Russian Federation and Asian countries. Problems, that European operators currently experience with Minsk FIR, are following:

- Different times for FPL submission
- Manual flight plan processing
- Lack of feedback on FPL status
- The need of overflight and landing permits connected to certain routing
- Complicated and tedious FPL changes

Inconsistencies and slow processes cause delays and reduce the airspace capacity. IFPS integration would be able to address all above-mentioned, except for the permits. Offered solution is to simplify the process and implement requests directly to the FPL message.

It was concluded, that estimated duration of IFPS integration for Belarus would be 2 months. Included is the pre-validation process, flight plan services adjustments, updates of aeronautical publications and staff training. In terms of technology, Belarus is fully capable to join the system and except for installing new software and adopting ADEXP, no further support is needed. Financially, most of the expenses are covered by EUROCONTROL. The biggest part, that Belarus would be responsible for, are costs related to the IFPS training. Using accessible sources, it was calculated, that the prospective amount of 460-1160 EUR per person would apply, depending on the circumstances and financial capabilities. Additionally, required training takes 66 hours, and, presumably, a standard hourly rate would be used to pay the employees.

According to the author, transition benefits such as technological development, EUROCONTROL's support and attracting new airliners exceed potential challenges. It is plausible to state, that Minsk FIR is a potential nominee for the next IFPZ country.

KALININGRAD FIR

Kaliningrad is located right in the middle of the IFPS Zone. The main problems experienced are:

- Lack of plannable routes due to many military corridors (no FUA)
- Frequent restrictions
- The concept of state preferences
- Problems with data sharing (applicable to the whole Russian Federation)

Unfortunately, in this case, IFPS integration is not the only answer to above-mentioned problems. The Russian Federation uses its own flight plan processing system, that has very similar procedures to IFPS, and works well. The main problem comes with Russian politics and data

sharing. However, Kaliningrad FIR could be used as a sort of testing region in terms of cooperation with EU. In the analysis, a solution is offered, in which IFPS would be implemented partially for European flights overflying the territory.

For FIR Kaliningrad, the estimated duration for IFPS integration was set to 5 months. As the Russian Federation uses a system with almost identical processes, no major operational changes need to be made. ADEXP and AFP implementation would be essential. Overflight permits requests could be transformed in the same way as described by Minsk FIR. Estimated costs related to IFPS training are 690-1360 EUR per person and required courses take 72 hours. Compared to Belarus, the training is extended by two e-learning modules connected to ATFCM.

In this case, reasons and advantages of Kaliningrad's entrance lie mostly on the EUROCONTROL's side and although the Russian Federation would undoubtedly benefit from this transition, it is not very likely to happen; political reasons are too strong.

This thesis contributes to better apprehension of the current air traffic situation and shows a solution to the question of possible capacity increase. It works with real data and represents a comprehensive analysis of states, whose IFPZ entrance would have the biggest impact on the whole network. The text could also serve as a basis for further examination in the future. Similar methodology can be used to evaluate other suitable candidates, for instance countries in Africa or in the Middle East. The analysis was conducted with the help and supportive information from EUROCONTROL staff and included are opinions and statements of flight planners from the Czech Republic, Great Britain, Germany and Turkey, who were interviewed. The author believes, that IFPZ expansion is an efficient respond to the increasing air traffic volumes, and hopes, that this thesis will be engaged as a constructive source for countries considering IFPS implementation.

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10 Attachments