MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE

NATIONAL AVIATION UNIVERSITY

EDUCATIONAL AND RESERCH FACULTY OF AIR NAVIGATION,

ELECTRONICS AND TELECOMMUNICATIONS

AIR NAVIGATION SYSTEMS DEPARTMENT

MASTER'S THESIS
ON THE EDUCATIONAL PROFESSIONAL PROGRAM
"AIR TRAFFIC SERVICE"
(EXPLANOTARY NOTE)

Theme: "Centralized airport SLOTs allocation system"

Performed by: _____M.S. Matlak

Supervisor: _____O.Y. Luppo

Standard inspector   _____G.F. Argunov

Kyiv 2020

МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ
НАЦІОНАЛЬНИЙ АВІАЦІЙНИЙ УНІВЕРСИТЕТ
ФАКУЛЬТЕТ АЕРОНАВІГАЦІЇ, ЕЛЕКТРОНІКИ ТА ТЕЛЕКОМУНІКАЦІЙ

КАФЕДРА АЕРОНАВІГАЦІЙНИХ СИСТЕМ

ДОПУСТИТИ ДО ЗАХИСТУ
Завідувач кафедри
д-р техн. наук, проф.
_____В.Ю. Ларін
«___»_____2020 р.

ДИПЛОМНА РОБОТА
(ПОЯСНЮВАЛЬНА ЗАПИСКА)
ВИПУСКНИКА ОСВІТНЬОГО СТУПЕНЯ МАГІСТРА
ЗА ОСВІТНЬО-ПРОФЕСІЙНОЮ ПРОГРАМОЮ
«ОБСЛУГОВУВАННЯ ПОВІТРЯНОГО РУХУ»

Тема: «*Централізована система розподілу аеропортових СЛОТів*»

Виконав: _____М.С. Матлак

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Київ 2020

NATIONAL AVIATION UNIVERSITY

FACULTY OF AI NAVIATION, ELECTONIC AND TELECOMMUNICATION

Air Navigation Department

Specialty 272 "Aviation Transport"

EPP: «Air Traffic Services»

APPROVED BY

Head of the Department

V. Larin

………………………

«…» …………… 2020

Graduate Student's Degree Thesis Assignment

<u>Mykhailo Matlak</u>

1. The Thesis topic: "Centralized airport SLOTs allocation system" approved by the Rector's order of 29.09.2020 №1815/ст.

2. The Thesis to be completed between 05.10.2020 –13.12.2020.

3. Initial data to the thesis (project): European Council Regulation (EEC) No 95/93, Standard Schedules Information Manual, Worldwide Airport Slot Guidelines IATA.

4. The content of the explanatory note (the list of problems to consider): analysis of existing airport slot allocation procedures, presentation of a centralized system,

development of algorithms for obtaining airport slots, comparison of existing and conceptual slot allocation system.

5. The list of mandatory graphic (illustrated) materials: 10 figures of explanatory material, 8 tables.

6. Calendar timetable

№	Completion stages of Degree Thesis	Stage completion dates	Remarks
1.	Preparation of chapter 1	05.10.20-23.10.20	complete
2.	Preparation of chapter 2	24.10.20-11.11.20	complete
3.	Preparation of chapter 3	12.11.20-30.11.20	complete
4.	Preparation of report and graphic materials	01.12.20-11.12.20	complete

7. Assignment accepted for completion: «__ » _____ 2020

Supervisor of graduate work _____Luppo O.Y.

(supervisor`s signature)   (name, surname)

The task is obtained for fulfillment by_____Matlak M.S.

(student`s signature)   (name, surname)

НАЦІОНАЛЬНИЙ АВІАЦІЙНИЙ УНІВЕРСИТЕТ

ФАКУЛЬТЕТ АЕРОНАВІГАЦІЇ, ЕЛЕКТРОНІКИ ТА ТЕЛЕКОМУНІКАЦІЙ

Кафедра аеронавігаційних систем

Спеціальність: 272 «Авіаційний транспорт»

ОПП: «Обслуговування повітряного руху»

ЗАТВЕРДЖУЮ

Завідувач кафедри

Ларін В.Ю.

………………………

«…» …………... 2020 р.

ЗАВДАННЯ

на виконання дипломної роботи магістра

Матлака Михайла Сергійовича

1. Тема дипломної роботи: «Централізована система розподілу аеропортових СЛОТів» затверджена наказом ректора від 29.09.2020 №1815/ст.

2. Термін виконання роботи (проекту): 05.10.2020 –13.12.2020.

3. Вихідні дані до роботи: European Council Regulation (EEC) No 95/93, Standard Schedules Information Manual, Worldwide Airport Slot Guidelines IATA.

4. Зміст пояснювальної записки: аналіз існуючих процедур розподілення слотів, представлення централізованої системи, розробка алгоритмів отримання слотів, порівняння існуючої та концептуальної системи розподілення слотів.

5. Перелік обов'язкового графічного (ілюстративного) матеріалу: 10 рисунків результатів проведених досліджень,8 таблиць.

6. Календарний план-графік

№ пор.	Завдання	Термін виконання	Відмітка про виконання
1.	Підготовка та написання 1 розділу	05.10.20-23.10.20	виконано
2.	Підготовка та написання 2 розділу	24.10.20-11.11.20	виконано
3.	Підготовка та написання 3 розділу	12.11.20-30.11.20	виконано
4.	Підготовка презентації та доповіді	01.12.20-11.12.20	виконано

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Керівник дипломної роботи _____ Луппо О.Є.

(підпис керівника)   (П.І.Б.)

Завдання прийняв до виконання _____Матлак М.С.

(підпис випускника)   (П.І.Б.)

ABSTRACT

Explanatory note to the thesis "Centralized airport SLOTs allocation system": 93 pages, 10 figures, 8 tables, 15 sources.

Purpose of the work — creation of an algorithm for the operation of the centralized airport SLOTs allocation system.

Research method — analysis of existing procedures for obtaining airport SLOTs, comparison of existing and conceptual procedures.

Relevance — currently, in order to receive SLOTs at Ukrainian airports, operators need to submit a separate application at each airport. Creating a single system will significantly speed up and improve the process of obtaining airport SLOTs.

Investigation object — procedures for obtaining airport SLOTs.

Projection according the research object — creation of a centralized system will greatly simplify and speed up the acquisition of airport SLOTs, which will improve the situation of Ukrainian airports, making them more attractive for flights by both Ukrainian and foreign operators.

The result of the thesis (algorithm of the system) is recommended to use to create and configure centralized airport SLOTs allocation system.

SLOTS, FLIGHT, CAPACITY, AIRPORT, COORDINATION, CENTRALIZED SYSTEM, AIRCRAFT OPERATORS, PROCEDURES, ALGORITHMS, AIR TRAFFIC, SCHEDULE.

РЕФЕРАТ

Пояснювальна записка до дипломної роботи «Централізована система розподілу аеропортових СЛОТів»: 93 сторінки, 10 рисунків, 8 таблиць, 15 використаних джерел.

Мета дипломної роботи — створення алгоритму для роботи централізованої системи розподілу аеропортових СЛОТів.

Методи дослідження — аналіз існуючих процедур отримання аеропортових СЛОТів, порівняння існуючих та концептуальних процедур.

Актуальність — на теперішній час для отримання СЛОТів в аеропортах України, експлуатантам необхідно подавати окрему заявку в кожен аеропорт. Створення єдиної системи значно прискорить та покращить процес отримання СЛОТів.

Об'єкт дослідження — процедури отримання аеропортових СЛОТів.

Прогнозовані припущення щодо розвитку об'єкта дослідження — створення централізованої системи значно спростить та прискорить отримання аеропортових СЛОТів, що покращить становище українських аеропортів зробивши їх більш привабливими для польотів як українських так і іноземних експлуатантів.

Результат дипломної роботи (алгоритм роботи системи) рекомендовано використовувати для створення та налаштування централізованої системи розподілу аеропортових СЛОТів.

СЛОТИ, РЕЙС, ПРОПУСКНА СПРОМОЖНІСТЬ, АЕРОПОРТ, КООРДИНАЦІЯ, ЦЕНТРАЛІЗОВАНА СИСТЕМА, ОПЕРАТОРИ ПОВІТРЯНИХ СУДЕН, ПРОЦЕДУРИ, АЛГОРИТМИ, ПОВІТРЯНИЙ РУХ, РОЗКЛАД.

LIST OF REMARKS

CONTENT

LIST OF ABBREVIATIONS AND TERMS

ASWG – Airport Slot Working Groups

ATC – Air Traffic Control

EOBT – Estimated Off Block Time

IATA – International Air Transportation Association

ICAO – International Civil Aviation Organization

SAL – Slot Allocation/Schedule Advice List

SAQ – Slot/Schedule Availability Query

SC – Schedules Conference

SCR – Slot Clearance Request/Reply

SIR – Slot/Schedule Information Request/Reply

SSIM – Standard Schedules Information Manual

SMA – Schedule Movement Advice

SHL – Slot Historical and Non-Historical Allocation List

UkSATSE – Ukrainian State Air Traffic Services Enterprise

UTC – Universal Time Coordinated

WASB – Worldwide Airport Slot Board

WASG – Worldwide Airport Slot Guidelines

WCR – Waitlist Change Request/Reply

WIR – Waitlist Information Request/Reply

Air carrier (**airline**) – an air transport undertaking holding a valid operating license or equivalent authorization from its national authority.

Aircraft – a vehicle that is able to fly by gaining support from the air.

Algorithm – is a set of rules (instructions) or control actions, the execution of which ends with the desired result.

Airport Infrastructure – the full range of airport facilities and any environmental or other components, used in the operation of services at an airport.

Airport Level – the classification of airports based on its level of congestion as Level 1, Level 2 and Level 3.

Airport Slot – a permission given by a coordinator for a planned operation to use the full range of airport infrastructure necessary to arrive or depart at a Level 3 airport on a specific date and time.

Coordination Committee – a committee established at a Level 3 airport to advise the coordinator on matters relating to capacity, slot allocation and monitoring the use of slots at the airport. Any references to a Coordination Committee in these guidelines also apply to any sub-group that the Coordination Committee may have created to address the relevant matters.

Coordinator – The organization or individual responsible for slot allocation at a Level 3 airport.

Demand and Capacity Analysis – the process of assessing airline demand and determining maximum airport capacity, taking into account all physical, operational, and environmental constraints at the airport.

Estimated Off - Block Time – the estimated time that an aircraft will start movement associated with departure.

Handling Agent – a person or organization that represents an airline at an airport in areas of passenger or cargo services, or aircraft dispatch.

Historic Precedence – the principle whereby airlines are entitled to a series of slots that were operated at least 80% of the time during the period allocated in the previous equivalent season.

Historic Slots – slots allocated on the basis of historic precedence.

Initial Coordination – the process that occurs between the Initial Submission Deadline and SAL Deadline dates for each season, whereby a coordinator allocates slots at a Level 3 airport and a facilitator recommends voluntary schedule adjustments at a Level 2 airport.

New Entrant – an airline requesting a series of slots at an airport on any day where, if the airline's request were accepted, it would hold fewer than 7 slots at that airport on that day. In other words, an airline could schedule 3 rotations per day (3 arrivals and 3 departures, requiring 6 slots) as a new entrant.

Responsible Authority – the government department, directorate, authority agency with responsibility for oversight and regulation of the airport concerned.

Slot Monitoring – an analysis carried out by coordinators to measure the operational performance of airlines compared with the slots allocated to them.

Slot Pool – the slots available at a Level 3 airport at initial allocation after unchanged historic slots are allocated, including any newly created slots.

Slot Swap – a process whereby allocated slots are swapped on a one-for-on basis between airlines at the same airport.

Slot Transfer – a process whereby allocated slots are transferred from one airline to another airline.

Shared operations – a generic term referring to various types of operational or commercial arrangements between two or more airlines.

Waitlist – a non-prioritized list of outstanding requests, including both allocated slots pending improvements and requests with no slot allocated.

INTRODUCTION

Scientific and technological development in the XXI century changed a lot of industries. Innovations have not spared the aviation sphere as well, brought air transportation to one of the most demanded, fast, and widespread kinds of transport. Air carriers reacted immediately that demand had increased and began to gain the volume of transportation. However, the better part of significant airports was built in the previous century, and their infrastructure has not been designed for volumes of nowadays traffic. The rapid growth of air transportations led to a shortage of available aircraft parking places, runways, and ground handling resources.

Air traffic continued to outstrip available infrastructure, therefore the number of delays grew very fast. Diversions of aircraft to alternate aerodromes have also become more frequent due to the impossibility of staying in the holding areas near the destination airports. The very high amount of ground and air delays coupled with diversions were leading to great losses for both air carriers and airports. Such situation would lead to the opposite effect, decreasing air transportation and slowdown in the development of the whole aviation industry.

To avoid traffic congestions due to exceeding of airport capacity were invented airport SLOTs. They have specified allotted time for an aircraft to land or take off at an airport as well as a time limit for aircraft ground handling. Through SLOTs, airport authorities managed traffic volume, dividing it into portions. Uniform continuous traffic has allowed to serve air transportations without extension of airport infrastructure and to avoid constant delays.

Usage of airport SLOTs also helped to deal with irregular distribution of frequencies of passenger flights in the big hub airports. Airlines that use the hub and spoke transportation concept have priority SLOTs in their own hub airports for useful transfer flights. At the same time, airlines, which use the point-to-point model, and have a desire to fly to the hub airports, have to revise their schedule to operate flights between rush hours of basic airport carriers. Equal distributions of frequencies give advantages for both airports and passengers. There is no downtime at airports, and passengers can choose more suitable time for a flight.

Nowadays, if carriers want to operate any type of flight in a conventional airport, besides permission to land, they would need to obtain airport SLOTs. Airport SLOTs obtaining procedure is not hard but may be very long. There are a lot of factors that can influence it, for example, type of aircraft, kind of operations, operator certificates, etc. All mentioned factors in busy airports make SLOT obtaining procedure unbearably difficult, and it leads to decrease in the attractiveness of the airport for operations.

Volume of air traffic is important for carriers and airports as well as for states. Considering all factors, raising the attractiveness of airports for operations must be supported or initiated by a state.

This work aims to create a concept of centralized airport SLOTs allocation system. This system will simplify and uniform procedures of SLOTs obtaining. For achieving this goal, the following tasks have been established:

- to analyze the airport SLOTs concept;
- to analyze existing SLOTs obtaining procedures;
- to create a theoretical base for the centralized airport SLOTs allocation system concept;
- to redesign existing procedures for a new concept;
- to create an algorithm for the system operations.

CHAPTER 1

AIRPORT SLOTS CONCEPT AND ORGANIZATIONAL PROCESS

1.1 Airport SLOTs basic principles

An airport SLOT - is a permission given by a coordinator for a planned operation to use the full range of airport infrastructure necessary to arrive or depart at the airport on a specific date and time. Simply put, this is the time allocated by the airport, within which the carrier can perform operations necessary for air transportation. Airport SLOTs were designed for the opportunity to handle high volumes of traffic without extension of airport infrastructure.

The IATA Slot Conference - is the forum for the coordination of planned operations at Level 2 and Level 3 airports, held twice each year for the summer and winter seasons. The June slot conference addresses the following winter season and the November slot conference addresses the following summer season. Slot conference allows IATA effectively manage issues concerning airport SLOTs allocation arise during previous, summer or winter, navigational seasons.

The Slot Conference is convened solely for the purpose of allocating and managing slots at Level 3 airports and discussing schedule adjustments at Level 2 airports. All recommendations from the conference, as a rule, are taken to work for their further implementation.

The Worldwide Airport Slot Guidelines (WASG) is published by Airports Council International, the IATA and the Worldwide Airport Coordinators Group to provide the global air transport community with a single set of standards for the management of airport SLOTs at coordinated airports and of planned operations at facilitated airports.[13].

The WASG is organized and presented in a way to allow easy access to the policies, principles and processes that support the allocation and management of airport SLOTs at congested airports worldwide. The WASG is overseen by the Worldwide Airport Slot Board, comprised of an equal number of airports, airlines and coordinators/facilitators.

The WASG is the industry standard recognized by many regulatory authorities for the management and allocation of airport capacity. In some instances, this text has been incorporated into local regulations and national law. The community of airports, airlines and SLOTs coordinators/facilitators from across the globe jointly produces the WASG.

The mandate of the WASB is to propose areas of policy development, consider ways of improving the procedures, and review and analyze future trends and technology. The WASB is responsible for establishing Airport Slot Working Groups (ASWG) to carry out focused and specific work on any issues deemed of interest for the industry.

All changes to the WASG are agreed by the WASB. This ensures that standards or best practices cannot be changed, or new items introduced into the WASG unilaterally by any airport, airline, SLOTs coordinator/facilitator or industry group.

1.2   Airport coordination basic principles

Airport coordination is a means of managing airport capacity through the application of a set of rules contained in these (WASG). Coordination involves the allocation of constrained or limited airport capacity to airlines and other aircraft operators to ensure a viable airport and air transport operation. Coordination is also a process to maximize the efficient use of airport infrastructure.

Coordination is not a solution to the fundamental problem of a lack of airport capacity. In all instances, coordination should be seen as an interim solution to manage congested infrastructure until the longer-term solution of expanding airport capacity is implemented. Airport SLOTs coordination does not use to solve a problem concerning operation out of airport working hours.

The stakeholders in airport coordination are airlines and other aircraft operators using or planning to use the airport, airport managing body that administers and manages the airport facilities, air traffic control authorities responsible for the airport and airspace, coordinator or facilitator responsible for coordination at the airport, government authorities responsible for the airport. [14].

1.2.1   Objectives of airport coordination

The prime objective of airport slot coordination is to ensure the most efficient declaration, allocation and use of available airport capacity in order to optimize benefits to consumers, taking into account the interests of airports and airlines:

a) To facilitate consumer choice of air services, improve global connectivity and enhance competition at congested airports for passengers and cargo.

b) To provide consumers with convenient schedules that meet demand, are consistent from one season to the next, and reliable in terms of their operability.

c) To ensure that slots are allocated at congested airports in an open, fair, transparent and non-discriminatory manner by a slot coordinator acting independently.

d) To realize the full capacity potential of the airport infrastructure and to promote regular reviews of such capacity and demand that enable effectual capacity declarations for slot allocation on a seasonal basis.

e) To balance airport access opportunities for existing and new airlines.

f) To provide flexibility for the industry to respond to regulatory and changing market conditions, as well as changing consumer demand.

g) To minimize congestion and delays.

1.2.2   Conditions for airport coordination

For the purposes of airport coordination, airports are categorized by the responsible authorities according to the following levels of congestion:

a) Level 1: airports where the capacity of the airport infrastructure is generally adequate to meet the demands of airport users at all times.

b) Level 2: airports where there is potential for congestion during some periods of the day, week, or season which can be resolved by schedule adjustments mutually agreed between the airlines and facilitator. A facilitator is appointed to facilitate the planned operations of airlines using or planning to use the airport.

c) Level 3: airports where capacity providers have not developed sufficient infrastructure, or where governments have imposed conditions that make it impossible to meet demand. A coordinator is appointed to allocate slots to airlines and other aircraft operators using or planning to use the airport as a means of managing the declared capacity. [13].

Nowadays, despite regulations of IATA concerning airport categorization, airports, which have «level 1» category use SLOTs for, own purpose. As a rule, airport authorities do this to simplify and unify airport operations.

1.2.3   Key principles of airport coordination

Since IATA is considering for SLOT coordination airport of "level 3" only, we will consider key features of coordination for "level 3" airport.

The key principles of airport SLOTs coordination are:

a) Slots are allocated to airlines by a duly appointed coordinator for planning purposes.

b) Slots can only be allocated to airlines or other aircraft operators.

c) An airline or other aircraft operator must have a slot allocated to it before operating at the airport. Certain types of flights (for example, humanitarian or state flights) may be exempt or subject to special local procedures.

d) Airlines and other aircraft operators must not intentionally operate services at a significantly different time or intentionally use slots in a significantly different way than allocated by the coordinator.

e) A series of slots is at least 5 slots allocated for the same or approximately same time on the same day-of-the-week, distributed regularly in the same season.

f) An airline is entitled to retain a series of slots for the next equivalent season if they were operated at least 80% of the time during the period for which they were allocated. This is referred to as historic precedence.

g) Historic slots may not be withdrawn from an airline to accommodate new entrants or any other category of aircraft operator. Confiscation of slots for any reason other than proven intentional slot misuse is not permitted.

h) Slots may be transferred or swapped between airlines, or used as part of a shared operation, subject to the provisions of these guidelines and applicable regulations.

i) Coordinators must be functionally and financially independent of any single interested party and act in a neutral, transparent, and non-discriminatory way.

j) The allocation of slots is independent from the assignment of traffic rights under bilateral air service agreements.

k) Airlines and coordinators must use the IATA Standard Schedules Information Manual message formats for communications at the airports.

l) Slot times are based on the planned on-block (arrival) and off-block (departure) times.

m) All activities involving slots, including the determination of historic slots, are in UTC, unless otherwise agreed.

1.3 Airports designation

Airports are designated following a thorough demand and capacity analysis, using commonly recognized best practice methods by the airport managing body or other competent body. The analysis should be completed in a timely manner to enable an official capacity declaration (the maximum capacity available for allocation considering the functional limitations at the airport such as runway, apron, terminal, airspace, and environmental restrictions) for each scheduling season. At a minimum, the analysis should be conducted whenever there are significant changes in airport infrastructure, operational practices, or patterns of demand. This analysis should use quantitative and transparent criteria for determining which level of coordination is appropriate for that airport. [15].

An airport is designated Level 2 when this analysis demonstrates that there is potential for congestion during some periods of the day, week, or season that could be resolved by Level 2 facilitation. An airport is designated Level 3 when this analysis

demonstrates a risk that demand may significantly exceed the capacity of the airport and that Level 3 slot coordination is required.

The responsible authority must ensure that an airport is only designated as Level 3 or remains as Level 3 following the analysis and consultation process described above.

1.3.1   Level 1 airports

A Level 1 airport is one where the capacity of the airport infrastructure is generally adequate to meet the demands of airport users at all times. Airlines operating or planning to operate at a Level 1 airport should give adequate notice of their planned operations to their appointed handling agent and either the airport managing body or the data collection agent if one is appointed. Operations at Level 1 airports are not addressed at the SC.

The airport managing body of a Level 1 airport should monitor demand for airport infrastructure and develop additional capacity when required to meet that demand. It is also responsible for working with handling agents and other agencies to avoid constraints that impact on airline operations. The airport managing body may request information from airlines on planned operations in specified formats. In some cases, it may appoint a data collection agent to undertake this task. [12].

It is the responsibility of the handling agent to make its own arrangements with the airport managing body to handle planned operations. Handling agents have a major responsibility to ensure that unnecessary constraints are not created either through poor planning or inadequate resources in their own operations.

1.3.2   Level 2 airports

A Level 2 airport is one where there is potential for congestion during some periods of the day, week, or season, which can be resolved by schedule adjustments mutually agreed between the airlines and facilitator.

The responsible authority must ensure the appointment of a facilitator following consultations with the airport managing body, the airlines using the airport, and their representative organizations. Previous airline scheduling knowledge or coordination

experience is a prerequisite for appointment. Facilitators must have sufficient time and resources to provide facilitation services in accordance with these guidelines. The facilitator must be independent and act in a neutral, transparent, and nondiscriminatory way.

All airlines operating or planning to operate at a Level 2 airport must submit details of their planned operations to the facilitator before operating at that airport. Airlines should be prepared to accept an alternative time if offered by the facilitator to avoid exceeding the coordination parameters, otherwise the airport may need to consider changing to Level 3.

The airport managing body must provide support to the facilitator in seeking full airline cooperation at Level 2 airports. It should provide the infrastructure necessary to handle planned airline operations within agreed levels of service. The airport managing body must keep the facilitator and all relevant stakeholders informed about any capacity limitations, and especially give timely warning if one or more of these limitations might be reached or exceeded in the near future. After consultation with stakeholders, the airport managing body or other competent body must inform the facilitator of any capacity changes and of the coordination parameters. This declaration must be completed as soon as possible and at least 14 days and not later than 7 days before the Initial Submission Deadline. [13].

The facilitator will:

a) Ensure the feasibility of the plans submitted by an airline so the coordination parameters of the airport are not exceeded;

b) Make available to relevant stakeholders details of the coordination parameters and utilization of the declared capacity;

c) Advise airlines if planned operations will exceed coordination parameters and facilitate a process of mutually agreed schedule adjustments to avoid exceeding these parameters.

d) Attend and participate in all SCs.

1.3.3   Level 3 airports

A Level 3 airport is one where:

a) Demand for airport infrastructure significantly exceeds the airport's capacity during the relevant period;

b) Expansion of airport infrastructure to meet demand is not possible in the short term;

c) Attempts to resolve the problem through voluntary schedule adjustments have failed or are ineffective;

d) As a result, a process of slot allocation is required whereby it is necessary for all airlines and other aircraft operators to have a slot allocated by a coordinator in order to arrive or depart at the airport during the periods when slot allocation occurs.

The responsible authority must ensure the appointment of a coordinator following consultations with the airport managing body, the airlines using the airport, and their representative organizations. Previous airline scheduling knowledge or coordination experience is a prerequisite for appointment. Coordinators must have sufficient time, resources, and expertise to provide coordination services in accordance with these guidelines. Coordinators should have computer systems that are capable of performing the functions necessary to comply with the Worldwide Airport Slot Guidelines and any local guidelines and regulation. Coordinators must be functionally and financially independent of any single interested party and act in a neutral, transparent, and non-discriminatory way. If the day-to-day coordination at an airport is transferred to a different coordination organization, the date of transfer to the new organization must be notified as soon as possible to all airlines operating at that airport and to the Secretariat of the WASB.

All airlines operating or planning to operate at a Level 3 airport must be allocated a slot by the coordinator before operating at that airport. Airlines should have adequate resources, expertise, and systems to effectively participate in the coordination process. Because slots at a Level 3 airport may not be available at peak times, it is essential that airlines operating or planning to operate at that airport should be prepared to develop

alternative plans if they are unable to obtain the slots they require. Some airports have few or even no suitable slots available. In these cases, airlines should be aware of alternative airports which could accommodate their planned operations. [7].

The airport managing body or other competent body should attempt to reach agreement on the appropriate coordination parameters with members of the Coordination Committee and relevant stakeholders. The coordination parameters should be updated twice each year – in conjunction with the scheduling seasons. Where airport constraints persist, the airport managing body should examine the capacity and implement the necessary capacity enhancements to allow for a redesignation to Level 2 or Level 1 at the earliest opportunity. The airport managing body or other competent body should provide relevant information to the coordinator in order to assist in applying the additional criteria for slot allocation.

The coordinator will:

a) Allocate slots to airlines and other aircraft operators in a neutral, transparent, and non-discriminatory way, on the basis of the applicable coordination parameters, and in accordance with the priority criteria of the WASG and any local guidelines and regulations.

b) Make available to relevant stakeholders details of the applicable coordination parameters, local guidelines and regulations, and any other criteria used in the allocation of slots, as soon as possible and at least 14 days and not later than 7 days before the Initial Submission Deadline for each SC, where possible. The coordinator shall inform the airlines as soon as possible and at least 14 days and not later than 7 days before the Initial Submission Deadline.

c) Make available to the airlines and to the airport managing body, as soon as all SALs are distributed, a list of slots allocated, remaining slots available and the reasons why slots were not allocated as requested.

d) Attend and participate in all SCs.

e) Monitor cancellations made after the Historic Baseline Date and any no utilization of slots for the purpose of applying the Use it or Lose it rule.

f) Perform slot monitoring.

g) Offer advice to airlines and the relevant authorities on all matters likely to improve airport capacity or slot allocation flexibility, and in particular on any area which will help the airport return to Level 2 or Level 1.

h) Address problems arising from conflicting requirements in such a way as to avoid any need for external intervention.

The Coordination Committee is established at a Level 3 airport to advise the coordinator on matters relating to capacity, slot allocation, and monitoring the use of slots at the airport. Sub-groups of the Coordination Committee, such as a Slot Performance Committee, can be used to focus on specific functions of the Coordination Committee, or topics of relevance.

The principal tasks of the Coordination Committee are to:

a) Advise on the possibilities of adjusting the capacity of the airport;

b) Provide a body to which airport capacity providers (such as ANSPs or airport managing bodies) should communicate the methods used for determining coordination parameters;

c) Consult on capacity and coordination parameters, on which slot allocation are based;

d) Advise on ways of achieving a better utilization of the capacity available;

e) Mediate in case of complaints from airlines or other aircraft operators related to slot allocation or slot monitoring which cannot be resolved between the airline or other aircraft operator and the coordinator in a mutually agreeable way;

f) Consider any problems related to transparency or sharing of data;

g) Consider any serious problems for new entrants at the airport concerned;

h) Oversee the activities of the sub-groups of the Coordination Committee, such as a Slot Performance Committee, where these exist;

i) Advise the coordinator on methods and parameters of slot monitoring, where a Slot Performance Committee does not exist;

j) Review development projects that are being undertaken at the airport that may impact coordination parameters and communicate (alongside other channels such as Airport Operator Committees) on such projects; and

k) Liaise and consult with other entities, such as Civil Aviation Authorities, governments, or regulators, to the extent that such entities are involved in the setting of coordination parameters.

Membership of the Coordination Committee is open to all airlines using the airport regularly and their representative organizations, the airport managing body, air traffic control authorities, and representatives of general/business aviation (where relevant). Airlines and other aircraft operators willing to operate, but not yet operating, at the airport can attend the meetings of the Coordination Committee as observers. The representatives shall have the adequate knowledge, expertise, and mandates to serve on the Coordination Committee. Preferably, the composition is tailored to the specific items to be discussed, and in most cases a registered delegate who attends the IATA Slot Conference is the preferred representative from their organization. The coordinator attends all meetings as an observer. [9].

The board of the Coordination Committee shall be selected periodically, for a fixed period. The chairperson (and vice-chairperson, if one exists) shall have no specific interest in any of the possible results of the functions of the Coordination Committee. It is recommended that the airport managing body appoints a secretary of the Coordination Committee who shall be responsible for the planning and minuting of meetings.

Meetings of the Coordination Committee should be held at least once per year, as well as when required to review the coordination parameters on a seasonal basis or to review planned changes in policy or capacity which could significantly affect coordination. Ideally, meetings of the Coordination Committee should be conducted in English.

The Coordination Committee should ensure that agendas and working documents are distributed to members in advance of the meetings, and that minutes are published promptly after each meeting and distributed to Coordination Committee members via email or made available by other means. The dates of Coordination Committee meetings should be published on the IATA and Worldwide Airport Coordinators Group (WWACG) websites.

1.4   Principles of SLOTs allocation

The key principles of slot allocation at a the airport are:

a) Slots are allocated to airlines by a duly appointed coordinator only for planning purposes at the airport.

b) Slots can only be allocated to airlines or other aircraft operators.

c) An airline or other aircraft operator must have a slot allocated to it before operating at the airport. Certain types of flights (for example, humanitarian or state flights) may be exempt or subject to special local procedures.

d) Airlines and other aircraft operators must not intentionally operate services at a significantly different time or intentionally use slots in a significantly different way than allocated by the coordinator.

e) A series of slots is at least 5 slots allocated for the same or approximately same time on the same day-of-the-week, distributed regularly in the same season.

f) An airline is entitled to retain a series of slots for the next equivalent season if they were operated at least 80% of the time during the period for which they were allocated. This is referred to as historic precedence.

g) Historic slots may not be withdrawn from an airline to accommodate new entrants or any other category of aircraft operator. Confiscation of slots for any reason other than proven, intentional slot misuse is not permitted.

h) Slots may be transferred or swapped between airlines, or used as part of a shared operation, subject to the provisions of these guidelines and applicable regulations.

i) Coordinators must be functionally and financially independent of any single interested party and act in a neutral, transparent, and non-discriminatory way.

j) The allocation of slots is independent from the assignment of traffic rights under bilateral air service agreements.

k) Airlines and coordinators must use the SSIM message formats for communications at the airports.

l) Slot times are based on the planned on-block (arrival) and off-block (departure) times.

m) All activities involving slots, including the determination of historic slots, are in UTC, unless otherwise agreed.

n) Monitoring of the use of allocated slots should be performed in a timely manner by the coordinator at the airport.

1.4.1   Priorities of SLOTs allocation

Coordinators should allocate the declared capacity based on the following broad priority order:

1) A series of scheduled services;

2) Ad hoc services;

3) Other operations. Airlines and other aircraft operators should use message formats specified in SSIM to request slots with the appropriate priority status.

Airlines may only hold slots that they intend to operate, transfer, swap, or use in a shared operation. To ensure that scarce capacity is not wasted, airlines must immediately return any slots they know they will not use. Even at short notice, it may be possible to reallocate returned slots to other operators. In particular, series of slots that an airline does not intend to operate must be returned no later than the Series Return Deadline. [13].

Use It or lose It rule considers historic precedence is only granted for a series of slots if the airline can demonstrate to the satisfaction of the coordinator that the series was operated at least 80% of the time during the period allocated in the previous equivalent season. Ideally coordinators should have slot series usage information available online, so airlines can check their own slot series usage for all their own flights anytime during a season. It nonetheless remains the sole responsibility of the airline to monitor the usage of their slot series. Coordinators should provide timely feedback to airlines about flights at risk of failing to meet the minimum 80% usage requirement during the season to allow the airline to take appropriate action. [12].

1.4.2   Primary criteria of SLOTs allocation

When developing a slot allocation plan for the SC based on initial submissions by airlines, coordinators should, in accordance with the coordination parameters, apply the following priorities.

The first priority of slot allocation is historic slots requested as unchanged or with changes that do not impact the coordination parameters (for example, a change in flight number). These slot requests are referred to herein as unchanged historic slots. For changes to historic slots that impact the coordination parameters (for example, a change in timing), airlines and other aircraft operators should clearly indicate the range of flexibility they are prepared to accept (if any) using the appropriate industry codes and format in their submission. For any requested changes that cannot be allocated within the applicable flexibility range, the coordinator should reallocate the unchanged historic slots to the airline or other aircraft operator concerned. [13].

Once unchanged historic slots have been allocated, the coordinator will establish a slot pool, including any newly created slots. 50% of the slots contained in the pool at initial slot allocation must be allocated to new entrant requests in accordance with 8.3.4 below, unless new entrant requests are less than 50%. Similarly, 50% of the slots contained in the pool at initial slot allocation must be allocated to non-new-entrant requests, unless such requests are less than 50%. Where this 50/50 balance is not achievable in a single season (for example, where there is a very limited number of slots available in the pool), the coordinator should correct this imbalance over the next equivalent season (or seasons, if that is not possible) to ensure that the pool is allocated equitably to both new entrants and non-new-entrants. [12].

A new entrant that has been offered slots within one hour before or after the time requested but does not accept this offer by the end of the first day of the SC, will not retain new entrant status for that season. If a new entrant is dissatisfied with the response from the coordinator to its slot request, then it may ask for a meeting of the Coordination Committee to seek to resolve the situation.

Within each category (new entrant requests, non-new-entrant requests, and requests for changes to historic slots), a request to extend an existing operation to

operate on a year-round basis should have priority over a new slot request. In evaluating whether the year-round priority applies, coordinators should allow flexibility on timings to cater for the differing requirements of short- and long-haul services.

1.4.3   Flexibility of SLOTs

Airport slots are not route, aircraft, or flight number specific and may be changed by an airline from one route or type of service to another. Such changes are subject to final confirmation by the coordinator. The coordinator's confirmation should be given promptly and should not be withheld unless coordination parameters would be exceeded, or these guidelines or local regulations would be violated.

Swapping slots between airlines is encouraged. Allocated slots may be swapped on a one-for-one basis at a Level 3 airport by any number of airlines. In the case of a swap involving newly allocated slots, which are slots other than historic slots or changed historic slots, the coordinator may refuse to confirm the swap if not satisfied that the swap improves the operating position of that airline. Dialogue between the coordinator and the airline is essential in such circumstances. Airlines engaging in slot swaps must notify the coordinator of every swap. The coordinator will confirm the feasibility of each swap and amend its database.

Slot transfers between airlines, whether or not for compensation or consideration, may only take place where they are not prohibited by the laws of the relevant country. Slots may only be transferred to another airline that is serving or planning to serve the same airport. The transfer of newly allocated slots, which are slots other than historic slots or changed historic slots, is not permitted until such slots have been operated for two equivalent seasons. This is to prevent airlines taking advantage of an enhanced priority, such as new entrant status, to obtain slots simply to transfer them to another airline. Airlines engaging in a slot transfer must notify the coordinator of every transfer. The coordinator will confirm the feasibility of the transfer and amend its database.

A shared operation involves slots held by one airline being used by another airline. Shared operations may only take place where not prohibited by the laws of the relevant

country. Under a shared operation, the original slot holder retains historic precedence, not the operator of the slots. The slot holder is responsible for initial submissions and typically retains control of the slots until the Series Return Deadline. The operating airline is responsible for all usage and performance requirements. [13].

1.5 Airport SLOTs monitoring

Flexibility of airport SLOTs allocation allows airlines to operate their flights much more easier via SLOT swapping, transferring, or operations share. However, this flexibility can lead to delays and other bad consequences for the airport. To avoid this, IATA delegated SLOTs usage monitoring procedures to the airport authorities and ATC units. Slot monitoring is intended to ensure that operations at a Level 3 airport are in accordance with the slots as allocated, that slots are used in line with the Use It or Lose It rule. Help ensure scarce capacity is not wasted, the smooth operation of airports for all stakeholders; and prevent the misuse of slots.

1.5.1 Key principles of SLOTs monitoring and pre-operation analysis

The key principles of SLOTs monitoring are as follows:

- SLOT monitoring involves both preoperative and postoperative analysis.

- SLOT monitoring is a continuous process which allows sufficient advance notice for corrective action to take place.

- SLOT monitoring requires accurate and reliable data provided – in a timely manner and in the agreed format – ideally by the airport managing body or by other relevant stakeholders as needed.

- The investigation of potential misuse of SLOTs should be based on data analysis.

- Coordinators may consult relevant stakeholders (such as the Coordination Committee, Slot Performance Committee, the airport managing body, or air traffic control) to review the findings of SLOT monitoring.

Coordinators may seek to prevent slot misuse by undertaking pre-operation analysis, a recommended process involving conformity checks before the day of operation. This process requires the coordinator to have the right data in the agreed

format available in a timely manner in order to complete its analysis. Airport managing bodies, airlines, and other aircraft operators shall provide the data requested by the coordinator, in the format agreed between the parties, for this purpose.

When the coordinator identifies a discrepancy between the published data and the allocated slot, the coordinator should communicate this to the airline or other aircraft operator to allow it to take corrective actions to avoid possible slot misuse. Despite the pre-operation analysis process, the responsibility to avoid slot misuse remains with the airline or other aircraft operator. The pre-operation analysis process is not a prerequisite for a coordinator to take action for potential slot misuse as part of the post-operation analysis, below. [15].

1.5.2   Post-operation analysis

The airport managing body shall provide to the coordinator a list of flown operations, in a timely manner and in the agreed format. The data supplied should include the scheduled time, the actual on/off block times, the flight number, destination, aircraft type, service type, number of seats, and any other necessary data requested by the coordinator. Where actual on/off block time data is unavailable, landing and take-off times shall be provided by the airport managing body, with a recommended taxi time adjustment as an estimate for the on/off block times. Variations in taxi times may affect the accuracy of the matching process, and caution must be used when not using actual on/off block times.

The coordinator shall match the actual operations to the allocated slots, creating a matched data set. This process should be done on a regular basis throughout the season. The coordinator may use similar additional data sources to identify potential slot misuse, such as ATC flight plans. Flights operated in accordance with the allocated slots will be credited towards the granting of historic precedence. Discrepancies detected in the matched data set will then be investigated as part of the slot performance process.

The coordinator should then analyze the discrepancies in the matched data set created under the data comparison process to identify potential slot misuse.

Coordinators should rely on data analysis to demonstrate potential slot misuse with the aim of targeting only the most obvious and impactful cases of potential slot misuse for further action. Where potential slot misuse is identified, the coordinator should then enter into coordinator-airline dialogue. The coordinator should avoid seeking unnecessary explanations regarding minor operational deviations. In analyzing whether the deviation represents potential misuse, the coordinator should consider whether the deviation is a result of an obvious operational disruption, reasonable tolerance or part of a pattern of repeated off-slot operations. [13].

Having identified evidence of potential slot misuse, the coordinator should then contact the airline or other aircraft operator concerned, in writing. This message should request an explanation for the discrepancy and any proposed corrective action the airline or other aircraft operator plans to take. A reasonable deadline for response must be given, and all dialogue with the airline must conclude before the Agreed Historic Deadline for the subsequent equivalent season.

Coordinators should try to identify slot performance issues as soon as possible and contact the airline or other aircraft operator concerned in a timely manner, giving it the opportunity to take corrective action during the current season. If an adequate explanation is provided or appropriate corrective action is taken by the airline or other aircraft operator, the coordinator should continue to monitor the situation. Where appropriate, the coordinator should also notify the airport managing body of the corrective action taken by the airline or other aircraft operator.

If the airline-coordinator dialogue process is unsuccessful, enforcement action shall be considered for intentional or repeated slot misuse. When deciding whether to pursue any enforcement action, in accordance with these guidelines and applicable law. There are circumstances where slot misuse is initially not deemed intentional but may become intentional during the season if the airline or other aircraft operator concerned does not take effective corrective actions following correspondence with the coordinator. Coordinators should communicate any actions taken by them against airlines or other aircraft operators to the airport managing body and other stakeholders (ideally through the Slot Performance Committee).

Slot Performance Committee should be established as a possible sub-group of the Coordination Committee at Level 3 airports. The role of the Slot Performance Committee shall be performed by the Coordination Committee if a Slot Performance Committee is not established. The Slot Performance Committee's objective is to advise the coordinator on any slot monitoring issues, with the objective of improving punctuality and reducing slot misuse. The Slot Performance Committee shall also guarantee a fair judgment of potential slot misuse.

Only matters related to slot performance may be discussed during Slot Performance Committee meetings, and due consideration should be given to applicable competition laws (following consultation with legal counsel, if necessary). Attendees should not divulge any competitively sensitive information at such meetings. By way of non-exhaustive example, attendees should not share information regarding pricing, costs, route schedules, route changes, aircraft capacity, use of a particular aircraft type or a particular aircraft on a route, or any information regarding an airline's commercial strategy. [13].

To the extent that an airline or other aircraft operator facing a hearing needs to convey such information to the coordinator, the other attendees should be warned at the beginning of the hearing so that arrangements can be made for any other attendees present to leave the meeting while such matters are discussed. The Slot Performance Committee does not replace the function of slot monitoring activities performed by the coordinator.

The twice-yearly SC is the primary forum for discussions of slots and schedule adjustments. The SC is not a forum for discussions or agreements involving the allocation of aircraft capacity, pooling operations, division of markets, or any other commercial arrangements relating to pricing, market entry, or aircraft capacity. Delegates should not engage in such discussions in preparation for the SC and must refrain from initiating or participating in such discussions during the SC. [14].

All airlines (IATA and non-IATA) with an operating license or that have applied for an operating license may participate in the SC. Coordinators and facilitators are

required to participate in the SC. Invited observers from other interested parties may also attend the SC.

First-time attendees (airlines, coordinators, facilitators, and observers) should contact IATA at least 30 days in advance so that prior administrative arrangements may be made, and to be briefed about their participation. Appointments during the SC should not be used to deal with current season issues. However, coordinators and facilitators must maintain the capability of handling current season issues during the dates when the SC is convened.

Airline delegates must be fully authorized by their management to act on behalf of their airline at the SC. Coordinators and facilitators should verify the accreditation status of an airline attending the SC before entering into any binding discussions. The coordinator or facilitator should meet with the accredited airline delegate(s) to discuss any adjustments required and to confirm any agreed changes.

Non-airline participants may be allowed into coordinators' or facilitators' offices and may observe bilateral discussions only with the express agreement of both the airlines and the coordinators or facilitators involved. They must not participate in any way in the coordination activity of any airport. Appointments for meetings at the SC should be made using the IATA AppCal. Slots allocated as offers that cannot be accepted immediately will be valid until the first meeting of the airline with the coordinator at the SC.

The coordination process continues after the close of the SC. Reallocation is a continuous process. Requests must be processed by coordinators and facilitators as soon as possible, and immediately where requests can be confirmed automatically. All requests must be processed within 3 business days or, if this is not possible, acknowledged with a pending reply. If an airline does not receive a reply within 3 business days, it should contact the coordinator or facilitator for clarification of the status of the request. Where a new or revised request cannot be accommodated within the coordination parameters, the coordinator or facilitator will offer the nearest available slot to the requested times and provide the reason why the original request could not be granted. [13].

1.6 IATA Standard Schedules Information Manual

The SSIM is the official set of standards, guiding the industry with recommended practices, messaging formats and data processing procedures that are to be used by all IATA member airlines and their business partners for the exchange of airline schedules, communication of airport coordination information and minimum connect time data.

The standard schedules information manual helps airlines and airports to manage schedule by using published procedures. However, this manual is not a law, airports and air carriers can cooperate with each other relying on the other agreements. If such cooperation is not prohibited by local aviation authorities and will not infringe on the interests of other operators, it can be carried out. [14].

Schedule coordination is very tricky process that requires analysis and transmission of very big amount of data. To simplify this process the SSIM declares several types of standard messages.

SHL (Slot Historical and Non-Historical Allocation List) - this is the message used by Coordinators to inform airlines of the slots that have been granted historic rights and those which have not for the equivalent following season.

SCR (Slot Clearance Request/Reply) - this is the message used by airlines and Coordinators to manage slot requests at Coordinated airports. Only during a specific phase of each season do the Coordinators use a different message known as SAL (see description further on).

SMA (Schedule Movement Advice) - this is the message used by airlines and Schedule Facilitators for managing authorized schedules at Schedules Facilitated airports. As in the previous case, during a specific phase of each season the Schedules Facilitators use a different message known as SAL (see description below).

SAL (Slot Allocation/Schedule Advice List) - this is the message that the Coordinator or Schedules Facilitator uses to inform airlines of the results of the initial allocation of slots/authorized schedules for a given season. From that time on, any changes to the schedule of an airline will be managed using the SCR or SMA messages.

SIR (Slot/Schedule Information Request/Reply) - this is the message used by airlines and Coordinators/Schedules Facilitators to exchange information on the allocated slots or authorized schedules at an airport

SAQ (Slot/Schedule Availability Query) - this is the message used by airlines and Coordinators/Schedules Facilitators to request/give information on the time periods in which it is possible to allocate a slot or authorize a schedule at an airport.

WCR (Waitlist Change Request/Reply) - this is the message used by airlines and coordinators to manage changes to the list of slots pending improvement.

WIR (Waitlist Information Request/Reply) - this is the message used by airlines and coordinators to exchange information on the content of the list of slots pending improvement.

In order to allow all airlines to electronically exchange information on amendments to their basic schedules, i.e. the planned and regularly operated flights, standard message formats have been agreed. The message formats have been designed to provide as much clarity as possible for the message users and the received message details can be processed either by computer or by manual methods. The Standard Schedules Message (SSM) forms part of a complex system of timetable information exchange.

1.7   Slot Clearance Request/Reply message

The SCR message is the most important message for schedule coordinator. This message allows us to request airport SLOTs and deal with the airport coordinator regarding SLOTs issues. The SCR message is split into several parts and contains all necessary information about operator-desired activities.

The SCR message contains three parts:

- message header;

- information data line(s);

- message footer.

The first one and the last one parts are standard, and commonly don't require serious changes, but middle part carriers all necessary information.

1.7.1 The SCR message description

Message header:

SCR > message type: SCR - Slot Clearance Request;

/ > creator reference (optional);

SSS > IATA schedules season concerned (S (summer) or W (winter) plus two numeric for the year);

DDMMM > date of message (day and month)

XXX > clearance airport concerned (IATA airport code)

Information data line:

- arrival message

CFFFFFFF*DDMMMDDMMM*NNNNNNN*SSSAAA*IIITTTT*J
1   2   3   4   5 6   7 8 9

- departure message

CFFFFFFF*DDMMMDDMMM*NNNNNNN*SSSAAA*TTTTIII*J
1   2   3   4   5 6   7 8 9

- combined message

CFFFFFFF*FFFFFFF*DDMMMDDMMM*NNNNNNN*SSSAAA*
1   2   3   4   5   6   7
*IIITTTT*TTTTIII *JJ
 8   9   10 11 12

Information, contained in the data line is described in table 1.1, for arrival and departure messages, and in table. 1.2 for the combined message. There are no rules on what type of data lines operators should use, combined or separated, to request airport SLOTs. Generally, it described in airport or state SLOTs coordination manual what data lines would be preferred.

Message footer:

SI > supplementary information (connected with the content of message);

GI >general information.

Table 1.1 - Description of information in departure or arrival data line in the SCR

№	Item name	Item description
1	Action code	Defines the exact function of the data line(s). Codes described in tbl. 1.3.
2	Arrival or departure flight number	Airline Designator (2-IATA or 3-ICAO characters code) Flight Number (minimum 3 digits and maximum 4 digits).
3	Period of operation(s)	Arrival date and departure date in format 2 digit for the day plus 3 letter for the month of operation.
4	Day(s) of operation(s)	Indication by digits from 1 to 7 where 1 is Monday and 7 is Sunday.
5	Number of seats	Quantity of seats, 3 digits for PAX flight, format 000 for cargo flight.
6	Aircraft type	IATA aircraft type according to IATA Aircraft Type directory.
7	**For arrival:** origin station **For departure:** departure time	Time format HH+MM in UTC, airport code in IATA 3 letters format.
8	**For arrival:** arrival time **For departure:** destination station	Time format HH+MM in UTC, airport code in IATA 3 letters format.
9	Service type code	Indicates main reason for operating flight. Codes described in tbl. 1.4.
*	Space character	Mandatory space character between data blocks.

Table 1.2 - Description of information in combined data line in the SCR

№	Item name	Item description
1	Action code	Defines the exact function of the data line(s). Codes described in tbl. 1.3.
2	Arrival flight number	Airline Designator (2-IATA or 3-ICAO characters code) Flight Number (minimum 3 digits and maximum 4 digits).
3	Departure flight number	
4	Period of operation(s)	Arrival date and departure date in format 2 digit for the day plus 3 letter for the month of operation.
5	Day(s) of operation(s)	Indication by digits from 1 to 7 where 1 is Monday and 7 is Sunday.
6	Number of seats	Quantity of seats, 3 digits for PAX flight, format 000 for cargo flight.
7	Aircraft type	IATA aircraft type according to IATA Aircraft Type directory.
8	Origin station	Airport code in IATA 3 letters format.
9	Arrival time	Time format HH+MM in UTC.
10	Departure time	Time format HH+MM in UTC.
11	Destination station	Airport code in IATA 3 letters format.
12	Service type code for arrival and departure	Indicates main reason for operating flight. First digit for arrival, second digit for departure. Codes described in tbl. 1.4.
*	Space character	Mandatory space character between data blocks.

1.7.2 The SCR message special codes description

There are two special codes in the SCR message, action code, and service type code. These codes were specially developed for airport coordination and spelled in SSIM. Action code is the special code that indicates the type of operation, air operators and coordinators use different codes. Action codes described in tbl. 1.3. Service type code is the special code that indicates the reason for flight operations or type of flight, for example, schedule passenger flight or cargo flight. Service type codes described in tbl. 1.4.

Table 1.3 - Description of IATA action codes

Codes used by airlines			
A	Acceptance of an Offer — No further improvement desired.	M	Schedule to be change for reason other than Action Code C.
B	New Entrant.	N	New Schedule.
C	Schedule to be changed for an operational reason.	P	Acceptance of an offer — Maintain Outstanding Request.
D	Delete Schedule.	Q	Request for Schedule Information.
E	Eliminate Schedule.	R	Revised Schedule (offer acceptable).
F	Historic Schedule.	V	New entrant with Year Round Status.
I	Revised Schedule (continuation from previous adjacent Season).	Y	New schedule (Continuation from previous adjacent Season).
L	Revised Schedule (No offer acceptable).	Z	Decline Offer.
Codes to be used by the airport coordinator or schedules facilitator			
H	Holding. Return to Historic.	T	Allocated Subject to Conditions
I	Availability Information.	U	Refusal, Not Eligible for Historic Precedence, No Slot Allocated.
K	Confirmation.	W	Unable to Reconcile Flight Information.
O	Offer.	X	Cancellation or Removed.
P	Pending Action or Advice.		

Table 1.4 - Description of IATA service type codes

Code	Code description
J	Schedule passenger normal service.
S	Schedule passenger shuttle mode.
U	Schedule passenger (service operated by surface vehicle).
F	Schedule cargo/mail.
V	Schedule cargo/mail (service operated by surface vehicle).
M	Schedule mail only.
Q	Schedule passenger\cargo (mixed configuration aircraft).
G	Additional flights passenger normal service.
B	Additional flights passenger shuttle mode.
A	Additional flights cargo/mail.
R	Additional flights passenger\cargo (mixed configuration aircraft).
C	Charter passenger only.
O	Charter special handling.
H	Charter cargo/mail.
L	Charter passenger\cargo (mixed configuration aircraft).
P	Non-revenue.
T	Technical test.
K	Training.
D	General aviation.
E	Special VIP flight.
W	Military.
X	Technical Stop.
I	Ambulance flight.
N	Business aviation or air taxi.

1.7.3 The SCR message example

Message example:

```
SCR
S19
01SEP
AYT
NUH3321 18SEP18SEP 0030000 164320 IST1900 P
CUH3322 18SEP18SEP 0030000 164320 2030KBP C
RUH3322 18SEP18SEP 0030000 164320 2000KBP C
SI HANDLIG AGENT CONFIRMED TURN-AROUND TIME 1H
GI BRGDS OCC ATLASJET UKRAINE
```

Message decoding:

SCR – message type slot clearance request/reply;

S19 – season summer 2019 year;

01SEP – date of message firs of September;

AYT – message concerned Antalya Airport.

N – new flight request;

UH3321 – flight number;

18SEP18SEP – period of operation 18 of September;

0030000 – third day of the week or Friday;

164 – aircraft contain 164 passenger seats;

320 – aircraft type Airbus A320;

IST – origin station Istanbul Airport;

1900 – arrival time 19:00 UTC;

P – non-revenue or positioning flight.

In the first information data line airline request a new airport SLOT for the arrival of the empty aircraft Airbus A320 capacity 164 from Istanbul airport at 19:00 UTC on Friday the 18th of September.

C/R – changed schedule/revised schedule;

UH3322 – flight number;

18SEP18SEP – period of operation 18 of September;

0030000 – third day of the week or Friday;

164 – aircraft contain 164 passenger seats;

320 – aircraft type Airbus A320;

2030/2000 – changed time/revised time;

KBP – destination station Kyiv Boryspil International Airport;

C – passenger charter flight.

In the next two information data lines considered revise operations, the airline wants to move flight on 30 minutes earlier, so departure SLOT to the Kyiv Boryspil International Airport at 20:30 UTC canceled and requested SLOT at 20:00 UTC. All other data the same as in the first line except flight number.

SI HANDLIG AGENT CONFIRMED TURN-AROUND TIME 1H – handling agent confirmed that 1 hour will be enough for ground operations, and this is the reason to change schedule.

GI BRGDS OCC ATLASJET UKRAINE – non-essential information, greetings from airline operational center.

1.8 Slot/Schedule information Request/Reply message

The SIR message is an informative message for airlines during coordination with the airports regarding airport SLOTs. With the SIR message operator can request information regarding airport SLOTs held by the coordinator. This is very helpful when the operator does not know if slots have already been confirmed, or which data held by the coordinator. The difference between SCR and SIR messages is that in SCR messages on specific requests always be done specific answers which would not concern other airline operations. In SIR messages, one request will concern almost all carrier operations in the specific airport.

The SIR message contains three parts:

- message header;

- information data line(s);

- message footer.

1.8.1 The SIR message description

Message header:

SIR > message type: SIR - Slot Information Request;

SSS > IATA schedules season concerned (S (summer) or W (winter) plus two numeric for the year);

DDMMM > date of message (day and month)

XXX > clearance airport concerned (IATA airport code)

Flight detail line:

- arrival flight(s) format

    QFFF   or
    1 2

    QFFF*DDMMMDDMMM
    1 2   3

- departure flight(s) format

    Q*FFF   or
    1 2

    Q*FFF*DDMMMDDMMM
    1 2   3

- turn-around flight(s) format

    QFFF*FFF   or
    1 2   3

    QFFF*FFF*DDMMMDDMMM
    1 2   3   4

Information, contained in the flight detail line is described in table 1.5.

Message footer:

SI > supplementary information (connected with the content of message);

GI >general information.

Table 1.5 - Description of information in flight detail line in the SIR

	Arrival and departure flight(s) format	
№	Item name	Item description
1	Action code	Defines the exact function of the flight detail line(s). Codes described in tbl. 1.3.
2	Airline designator	Airline Designator (2-IATA or 3-ICAO characters code) or flight number.
3	Query period	Start and end of the period in format 2 digit for the day plus 3 letter for the month.
*	Space character	Mandatory space character between data blocks.
	Turn-around flight(s) format	
№	Item name	Item description
1	Action code	Defines the exact function of the flight detail line(s). Codes described in tbl. 1.3.
2	Airline designator for arrival flight(s)	Airline Designator (2-IATA or 3-ICAO characters code) or flight number.
3	Airline designator for departure flight(s)	
4	Query period	Start and end of the period in format 2 digit for the day plus 3 letter for the month.
*	Space character	Mandatory space character between data blocks.

1.8.2 The SIR message example

Message example:

SIR
S19
01SEP
AYT
QUJX UJX 10SEP28SEP
SI ALSO PLS SEND US NEW OFFERS FOR WAITLIST
GI BRGDS OCC ATLASJET UKRAINE

Message decoding:

SIR – message type slot/schedule information request/reply;

S19 – season summer 2019 year;

01SEP – date of message firs of September;

AYT – message concerned Antalya Airport.

Q – request for schedule information;

UJX – Airline designator for arrival flight(s);

UJX – Airline designator for departure flight(s);

10SEP28SEP – query period from 10 till 28 of September.

SI ALSO PLS SEND US NEW OFFERS FOR WAITLIST – airline asks the coordinator to propose airport SLOTs for requests which have not been confirmed.

GI BRGDS OCC ATLASJET UKRAINE – non-essential information, greetings from airline operational center.

In this SIR message airline, Atlasjet Ukraine asks the Antalya Airport coordinator about schedule information concerning the period from 10 till 28 of September for arrival and departure flights, and also about possible offers for SLOTs which have been declined. For this request, airport coordinator will send SIR message with all information regarding airport SLOTs for the mentioned period. Offers for the airline coordinator will send as a separate SCR message.

1.9   Example of coordination between airport and aircraft operator

Let's take an example that an aircraft operator is the airline already performs flights to an airport. Airline desire to change schedule of charter flights. The first step in particular schedule coordination is to request information about confirmed SLOTs from the airport coordinator. This can be done by SIR message.

Message example:

```
SIR
S19
01SEP
AYT
QUJX UJX 10SEP28SEP
SI ALSO PLS SEND US NEW OFFERS FOR WAITLIST
GI BRGDS OCC ATLASJET UKRAINE
```

Message decoding:

This message has decoded in point 1.8.2.

Coordinator answer example:

```
SIR
S19
01SEP
AYT
KUH3323 01AUG30SEP 1004060 164320 KBP0700 C
KUH3324 01AUG30SEP 1004060 164320 1900KBP C
KUH3322 18SEP18SEP 0030000 164320 2030KBP C
GI BRGDS AYT SLOT COORDINATORS
```

Message decoding:

SIR – message type slot/schedule information request/reply;

S19 – season summer 2019 year;

01SEP – date of message firs of September;

AYT – message concerned Antalya Airport.

K – confirmed schedule;

UH3323/ UH3324/ UH3322 – flight numbers;

01AUG30SEP/18SEP18SEP – period of operation from 1 of august till 30 of September/18 of September;

1004060/0030000 – days of operation: Monday, Thursday and Saturday./Friday;

164 – aircraft contain 164 passenger seats;

320 – aircraft type Airbus A320;

KBP0700 – origin station Kyiv Boryspil International Airport, arrival time 07:00 UTC;

1900KBP/2030KBP – destination station Kyiv Boryspil International Airport, departure time 19:00 UTC/20:30 UTC

C – passenger charter flight.

GI BRGDS AYT SLOT COORDINATORS – non-essential information, greetings from coordination center.

After receiving a schedule information, the airline can bring all necessary changes using SCR message.

Message example:

SCR
S19
01SEP
AYT
NUH3321 18SEP18SEP 0030000 164320 IST1900 P
CUH3322 18SEP18SEP 0030000 164320 2030KBP C
RUH3322 18SEP18SEP 0030000 164320 2000KBP C
SI HANDLIG AGENT CONFIRMED TURN-AROUND TIME 1H
GI BRGDS OCC ATLASJET UKRAINE

Message decoding:
This message has decoded in point 1.7.3.

Coordinator answer example:

SCR
S19
01SEP
AYT
KUH3321 18SEP18SEP 0030000 164320 IST1900 P
KUH3322 18SEP18SEP 0030000 164320 2000KBP C
XUH3322 18SEP18SEP 0030000 164320 2030KBP C
GI BRGDS AYT SLOT COORDINATORS

Message decoding:

SCR – message type slot clearance request/reply;

S19 – season summer 2019 year;

01SEP – date of message firs of September;

AYT – message concerned Antalya Airport.

K/X – confirmed schedule/deleted schedule;

UH3321/UH3322 – flight numbers;

18SEP18SEP – period of operation 18 of September;

0030000 – third day of the week or Friday;

164 – aircraft contain 164 passenger seats;

320 – aircraft type Airbus A320;

IST1900 – origin station Istanbul Airport, arrival time 19:00 UTC;

2000KBP/2030KBP – destination station Kyiv Boryspil International Airport, departure time 19:00 UTC/20:30 UTC;

P/C – non-revenue or positioning flight/passenger charter flight.

GI BRGDS AYT SLOT COORDINATORS – non-essential information, greetings from coordination center.

The airport coordinator confirmed all airline SLOTs request thereby approving the schedule.

CONCLUSION TO CHAPTER 1

In the modern world, with the great development of the aviation industry, it has become not so easy to fly to any airports in the world. The existing airport infrastructure has ceased to deal with the volume of air traffic. It is impossible to build new and improve old airports in a short period. To enable airports to work with modern traffic volumes, the concept of airport slots was created.

International organizations such as ICAO and IATA have created a large number of procedures and requirements for the quality operation of the airport slot concept. For a more accessible understanding of the policies, requirements and procedures associated with the allocation of airport slots and the coordination of the schedule, was created Worldwide Airport Slot Guidelines. This manual formulates the requirements for carriers, categorizes airports and outlines all procedures for coordinating flights.

To provide the airline industry with an official set of neutral recommended practices to guide the industry along mutually compatible lines in the development of schedule data handling procedures IATA create Standard Schedule Information Manual. In overly congested airports, to avoid unfair distribution of airport slots and the regulation of all issues, the coordination of airport slots is carried out directly by a special department of IATA.

Summarizing the first chapter, we see that to operate a flight to an airport in which the demand of air carriers significantly exceeds the available infrastructure, airlines need to request airport slots. These airports are classified as WASG as level 3 airports. At the moment, all procedures for coordinating airport slots shown in the example in point 1.9 are described in SSIM. Also, local authorities may introduce additional requirements, which can be found separately. For the correct and efficient operation of the airport slot concept, all requirements must be fully complied with by aircraft operators, and airport coordination centers must honestly coordinate schedules without lobbying.

Today, for the request of airport slots, aircraft operator have to authorize a special department, which deals with scheduling or air navigation support. The algorithms for requesting airport slots can be found in the following chapters. The procedures for

obtaining airport slots are a simple set of rules and actions that must be followed following the guidelines. However, in order to correctly formulate a request, the aircraft operator's staff must analyze a large number of factors and have a clear understanding of the period required for the flight schedule.

CHAPTER 2

ALGORITHMS OF AIRPORT SLOTS COORDINATION

2.1 General principles of algorithms

An algorithm is a set of rules (instructions) or control actions, the execution of which ends with the desired result. The name "algorithm" is associated with the name Al-Khwarizmi, who wrote a scientific treatise on arithmetic operations on numbers given in the decimal positional number system around 825. In the 12th century, the treatise appeared in Europe in translation from Arabic into Latin. The translator's name is unknown. The phrase "Dixit algorithms" is often used in the translation. This led to the emergence of the name of the concept of an algorithm, which began to refine since ancient times due to the impossibility of solving some geometric problems within a fixed, allowed by the conditions of the problem, means.

The concept of an algorithm is associated with information processing. In this sense, the algorithm is a task in certain expressive means of the process of information transformation. When setting the algorithm specify: the method of presentation (encoding) of information, the initial information, the allowable transformations in a given representation, the method of organizing the process of execution of the algorithm.

The result of the algorithm - information after its completion. The method of presenting information and its permissible transformations depend on the selected computational model in which the algorithm is implemented. For example, information can be encoded with bit strings or strings of characters, numbers, arrays, lists of pointers, files, and so on. Information transformations can be determined by functions, mathematical operators, commands of a computing device, or in another clearly defined way. [1].

Important in the concept of algorithm is the way of organizing the process of its execution. In sequential algorithms, the execution of local transformations of information takes place step by step. In deterministic algorithms, the transformation of information at each execution step and the next step are uniquely determined by the

previous steps of the algorithm execution. In the nondeterministic algorithm at each step of execution allow the choice of several possibilities of its continuation. In probabilistic algorithms, each possible choice of the next step is assigned some probability. Parallel algorithms are characterized by the simultaneous execution of several processes of information transformation and their interaction. Evolutionary, quantum, genetic, linguistic, and other numerous classes of algorithms have also been studied, reflecting certain aspects of the diversity of computational models created by analogy with the physical processes of the surrounding world.

In the classical theory of algorithms, the main emphasis is placed on the concept of principle computability, and the form of setting algorithms is less important. A characteristic feature of traditional classical definitions of the algorithm is the choice of the minimum means for presenting and transforming information to ensure the convenience of formalizing the concept of the algorithm to prove mathematical facts.

The procedures of specific calculations recorded with such minimal means are reduced to complex coding and modeling of information transformation, they are usually so cumbersome and difficult to understand that they can not be used in real programming practice for computers. [6].

Algorithms have a number of important properties:

- Finiteness - the algorithm should always be completed after a finite number of steps. A procedure that has the remaining characteristics of the algorithm, without possibly finiteness, is called the calculation method.

- Discreteness - (a process determined by an algorithm) can be divided into separate elementary stages (steps), each of which is called a step of an algorithmic process or algorithm.

- Definiteness - each step of the algorithm must be precisely defined. The actions to be performed must be clearly and unambiguously defined for each possible case

- Input data - the algorithm has a certain amount of input data, values set before its operation or whose values are determined during the operation of the algorithm.

- Output data - the algorithm has one or more output data, values that have a well-defined relationship with the input data.

- Efficiency - an algorithm is considered effective if all its operators are simple enough to be executed accurately over a finite period of time.

- Mass character - property of the algorithm, which is that the algorithm must provide the solution of any problem from the class of similar problems on any input data belonging to the scope of the algorithm.

We need to notice that an important feature of algorithms will be missed if we consider aviation procedures, namely the mass character of algorithms. All aviation procedures very specific for particular cases to maximize safety and efficiency.

Algorithm recording forms:

- verbal (linguistic, formulaic-verbal);
- program code (formal algorithmic languages);
- schematic (structures or graphics).

In this thesis, I will use schematic algorithms for easier visual comprehension of schedule coordination procedures. Those algorithms are also easier to compare because we simply can count the number of algorithm stages and make a conclusion. After all, the fewer stages means more automation, the easier and more convenient the process.

All algorithmic processes can be divided into three main types:

- Linear;
- Branched;
- Cyclic.

These three algorithmic processes can be combined with each other in different stages of the algorithm sequence. Despite the different methods of constructing algorithms, their task remains unchanged, after carrying out the required number of actions to obtain the result.

Linear - computational processes characterized by the fact that the steps of the algorithms are performed strictly sequentially in the order in which they are presented. The most simple algorithm type.
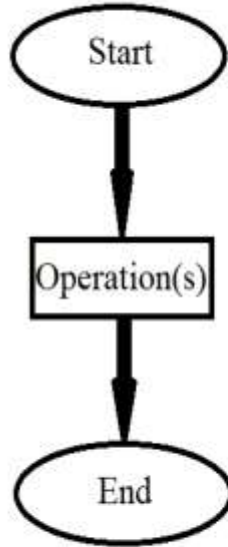
Figure 2.1 - Linear algorithm

Branched computational processes - computational processes in which, depending on the value of a feature, calculations are performed in one of some possible directions.
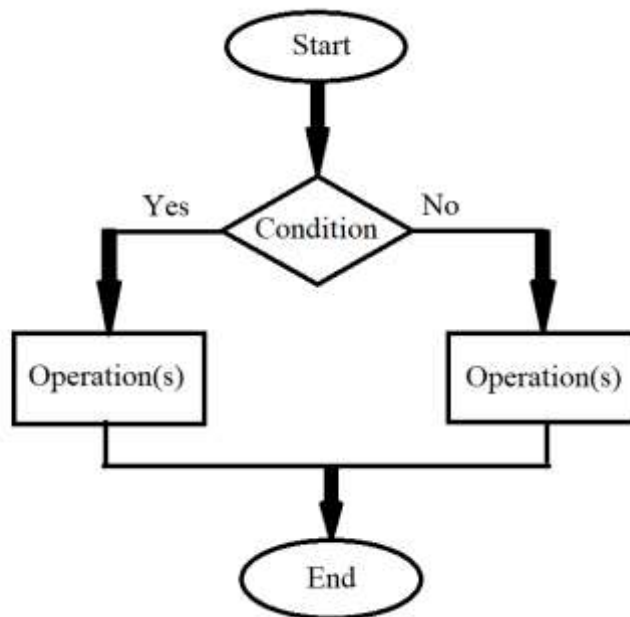

Figure 2.2 - Branched algorithm

Cyclic computational processes. The stage (section) of the algorithm, which is performed many times in the process of solving the problem, is called a cycle. Accordingly, computational processes that contain cycles are called cyclic. [8].
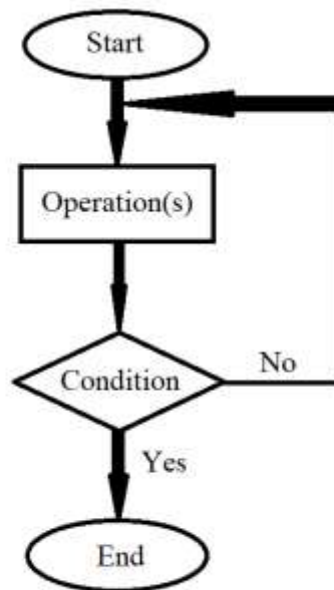

Figure 2.3 - Cyclic algorithm

Informally, an algorithm is a base of all existing procedures, including aviation. For schedule coordination, the community also has published procedures that supposed complete sequence of actions. If we believe that an algorithm is a sequence of specific actions, then it is obvious that there is also an algorithm for coordinating the schedule. Algorithms of airport SLOTs obtaining, for schedule and charter flights, described further.

An important feature of the algorithms is that if it is impossible to describe the process with one type of algorithm, we can always turn it into another. An example of this action is the algorithms below, which are based on the analysis of existing procedures. In our case, it is very difficult to create a manual for schedule coordination with a huge amount of graphically described procedures. All procedures in the aviation industry are built individually for each situation, taking into account all its features. All of the algorithms are turned into text instructions or procedures, which compose the manual.

2.2   Algorithm of airport SLOTs coordination for charter flights

All structural algorithms in this work are not accurate graphical representations of existing procedures for obtaining airport SLOTs and may not include the specific features of these procedures. All the stages in these algorithms in which there are conditions are specially formulated for the answers "yes" and "no" to the questions in the condition to simplify the perception of the procedures for obtaining airport SLOTs and their comparison. These algorithms can be used as a foundation for the creation of airports SLOTs obtaining procedure for aircraft operators responsible departments or other involved units and authorities.

Based on the analysis of procedures and requirements for obtaining airport SLOTs, as well as examples of airport SLOTs coordination, I created algorithms of actions for aircraft operators. There are two algorithms for scheduled flights and for charter flights, which are relevant to existing procedures of airport SLOTs obtaining.

The algorithm of airport SLOTs coordination for charter flights consist of 22 steps, not including "start" and "end" stages, and shown in figure 2.4 further. This algorithm is a branched type algorithm with several cycle steps. Depending on different conditions, necessary actions for SLOTs coordination can be performed very fast or vice versa.

An example of coordination that has been described in point 1.9 was the perfect example of schedule coordination. In the example aircraft operator chose the time within which the airport was able to handle the flights. There were no issues with the SLOTs offer or restrictions. As a rule, there are no major problems for charter flights to get airport slots, because most of these flights are tourist charter flights, that operate at night when airports are less busy.

In real conditions process of airport SLOTs obtaining can be much longer and create additional challenges for the aircraft operators, and with help of this algorithm, we can make sure of this.
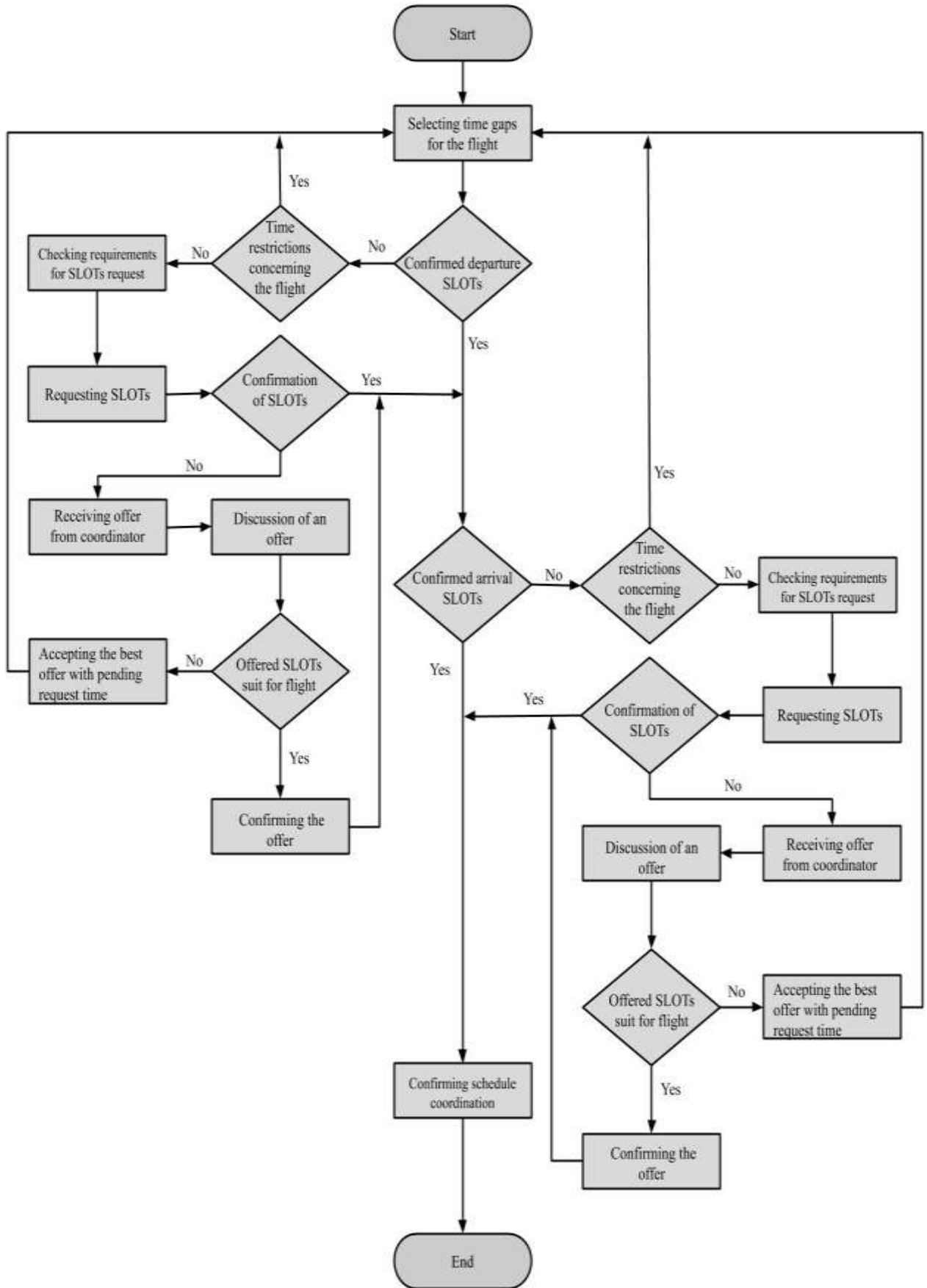
Figure 2.4 - Algorithm of airport SLOTs coordination for charter flights

Algorithm description:

1) Step - "Selecting time gaps for the flight", during this step department of the aircraft operator responsible for the schedule decided at what time operator have to perform the flight or discuss essential changes in the schedule.

2) Step - "Confirmed departure SLOTs", during this step department responsible for obtaining airport SLOTs have to check existence of confirmed SLOTs for the origin airport.

3) Step - "Time restrictions concerning the flight", during this step responsible department have to check existence of any restrictions in the departure airport for the time that would be needed to operate the flight.

4) Step - "Checking requirements for SLOTs request", during this step responsible department have to check additional requirements and procedures for SLOTs request set by the state and/or airport authorities, and satisfy them.

5) Step - "Requesting SLOTs", during this step responsible department have to send request for the airport SLOTs to the airport coordinator.

6) Step - "Confirmation of SLOTs", during this step the airport coordinator processes request and defines ability of the airport to handle the flight at the specified time, and then, depends on ability, sends confirmation or offer for another SLOTs to the operator.

7) Step - "Receiving offer from coordinator", during this step department responsible for obtaining airport SLOTs in case of refusal from coordinator have to check offer and transfer information for processing to the department responsible for the schedule.

8) Step - "Discussion of an offer", during this step department responsible for the schedule have to discuss possibility to change the schedule.

9) Step - "Offered SLOTs suit for flight", during this step department responsible for the schedule have to define suitability of the airport SLOTs offered by the coordinator to operate flight.

10) Step - "Confirming the offer", during this step department responsible for obtaining airport SLOTs have to send confirmation of the offer to the airport coordinator.

11) Step - "Accepting the best offer with pending request time", during this step aircraft operator can not accept SLOTs offered by the coordinator. Responsible unit have to define the most suitable SLOTs and inform department responsible for obtaining airport SLOTs. Department responsible for obtaining airport SLOTs have to send confirmation of the most suitable SLOTs and get on the waitlist in order to be able to obtain needed SLOTs.

12) Step - "Confirmed arrival SLOTs", during this step department responsible for obtaining airport SLOTs have to check existence of confirmed SLOTs for the destination airport.

13) Step - "Time restrictions concerning the flight", during this step responsible department have to check existence of any restrictions in the arrival airport for the time period that would be needed to operate the flight.

14) Step - "Checking requirements for SLOTs request", during this step responsible department have to check additional requirements and procedures for SLOTs request set by the state and/or airport authorities, and satisfy them.

15) Step - "Requesting SLOTs", during this step responsible department have to send request for the airport SLOTs to the airport coordinator.

16) Step - "Confirmation of SLOTs", during this step the airport coordinator processes request and defines ability of the airport to handle the flight at the specified time, and then, depends on ability, sends confirmation or offer for another SLOTs to the operator.

17) Step - "Receiving offer from coordinator", during this step department responsible for obtaining airport SLOTs in case of refusal from coordinator have to check offer and transfer information for processing to the department responsible for the schedule.

18) Step - "Discussion of an offer", during this step department responsible for the schedule have to discuss possibility to change the schedule.

19)   Step - "Offered SLOTs suit for flight", during this step department responsible for the schedule have to define suitability of the airport SLOTs offered by the coordinator to operate flight.

20)   Step - "Confirming the offer", during this step department responsible for obtaining airport SLOTs have to send confirmation of the offer to the airport coordinator.

21)   Step - "Accepting the best offer with pending request time", during this step aircraft operator can not accept SLOTs offered by the coordinator. Responsible unit have to define the most suitable SLOTs and inform department responsible for obtaining airport SLOTs. Department responsible for obtaining airport SLOTs have to send confirmation of the most suitable SLOTs and get on the waitlist in order to be able to obtain needed SLOTs.

22)   Step - "Confirming schedule coordination", during this step responsible unit have to confirm that all airport SLOTs for the flight have been obtained and schedule coordinated.

2.3   Algorithm of airport SLOTs coordination for scheduled flights

The main differences between scheduled (regular) and charter flights SLOTs coordination are in availability of priority status during SLOTs coordination for scheduled flights, and schedule flights SLOTs coordination must be completed in accordance to IATA calendar of coordination. A feature of coordination for charter flights for the operator is the flexibility of charter flights schedule that is much easier to change.

The algorithm of airport SLOTs coordination for scheduled flights consist of 36 steps, not including "start" and "end" stages, and shown in figure 2.5. This algorithm is a branched type algorithm with several cycle steps. Different options like shared operations or SLOTs swap between airlines are not considered in this algorithm as separate steps for a better comprehension of challenges that may have an airline without priorities.
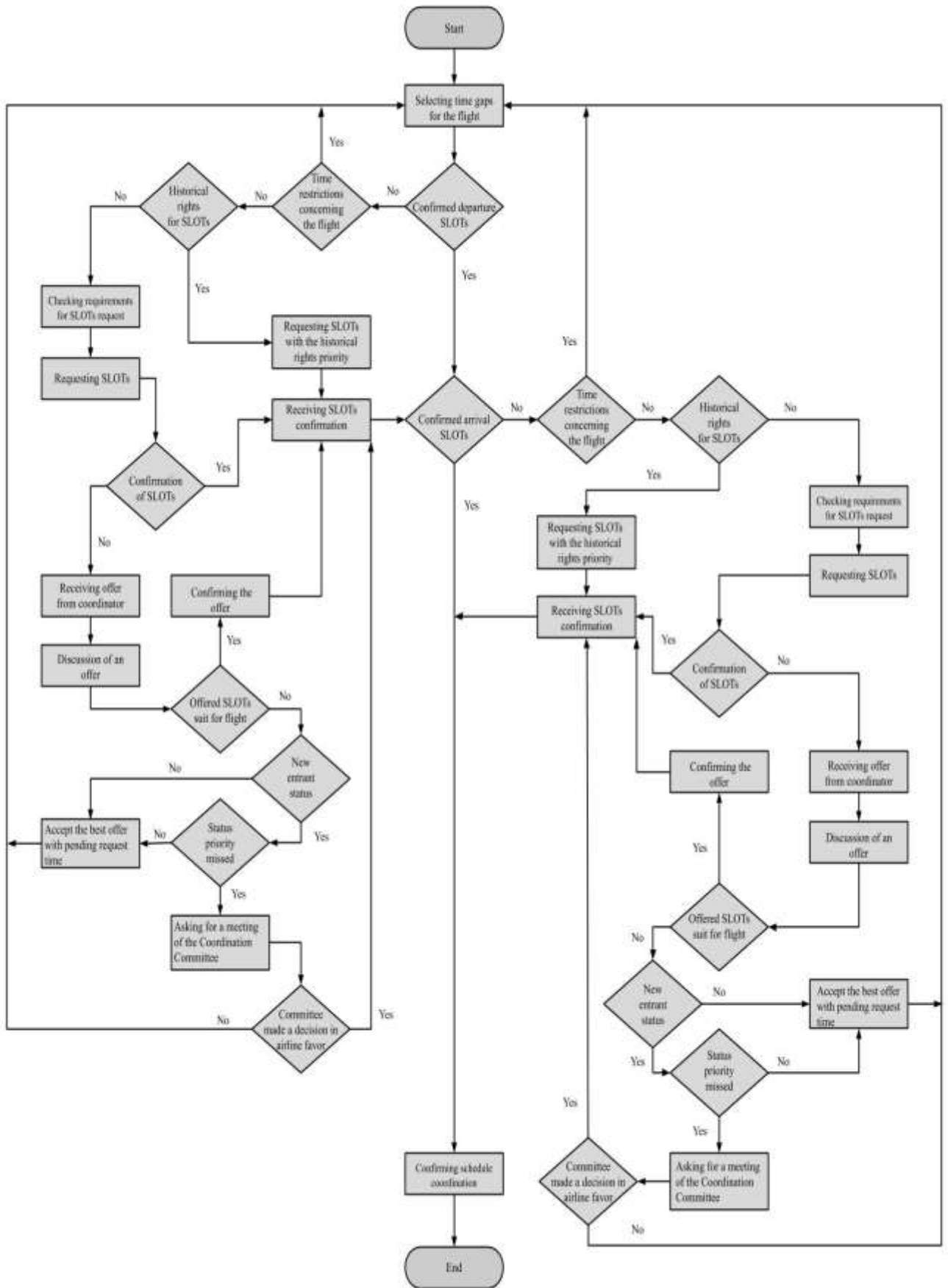
Figure 2.5 - Algorithm of airport SLOTs coordination for scheduled flights

Algorithm description:

1)   Step - "Selecting time gaps for the flight", during this step department of the aircraft operator responsible for the schedule decided at what time operator have to perform the flight or discuss essential changes in the schedule.

2)   Step - "Confirmed departure SLOTs", during this step department responsible for obtaining airport SLOTs have to check existence of confirmed SLOTs for the origin airport.

3)   Step - "Time restrictions concerning the flight", during this step responsible department have to check existence of any restrictions in the departure airport for the time period that would be needed to operate the flight.

4)   Step - "Historical rights for SLOTs", during this step responsible department have to check availability of historical rights priority for the airport SLOTs at the departure airport.

5)   Step - "Requesting SLOTs with the historical rights priority", during this step if the operator has historical priority for the airport SLOTs responsible department have to send request for the airport SLOTs to the airport coordinator based on historical rights.

6)   Step - "Receiving SLOTs confirmation", during this step department responsible for obtaining airport SLOTs have to receive confirmation of request from the airport coordinator.

7)   Step - "Checking requirements for SLOTs request", during this step responsible department have to check additional requirements and procedures for SLOTs request set by the state and/or airport authorities, and satisfy them.

8)   Step - "Requesting SLOTs", during this step if there are no historical rights responsible department have to send request for the airport SLOTs to the airport coordinator on general terms.

9)   Step - "Confirmation of SLOTs", during this step the airport coordinator processes request and defines ability of the airport to handle the flight at the specified time, and then, depends on ability, sends confirmation or offer for another SLOTs to the operator.

10)   Step - "Receiving offer from coordinator", during this step department responsible for obtaining airport SLOTs in case of refusal from coordinator have to check offer and transfer information for processing to the department responsible for the schedule.

11)   Step - "Discussion of an offer", during this step department responsible for the schedule have to discuss possibility to change the schedule.

12)   Step - "Offered SLOTs suit for flight", during this step department responsible for the schedule have to define suitability of the airport SLOTs offered by the coordinator to operate flight.

13)   Step - "Confirming the offer", during this step department responsible for obtaining airport SLOTs have to send confirmation of the offer to the airport coordinator.

14)   Step - "New entrant status", during this step defines availability of new entrant status of the airline.

15)   Step - "Status priority missed", during this step if the airline requested SLOTs with new entrant status or another priority status, responsible unit defines coordinator violations during distribution of the SLOTs. The airline may ask for a committee meeting depending on whether there have been any violations.

16)   Step - "Accepting the best offer with pending request time", during this step aircraft operator can not accept SLOTs offered by the coordinator. Responsible unit have to define the most suitable SLOTs and inform department responsible for obtaining airport SLOTs. Department responsible for obtaining airport SLOTs have to send confirmation of the most suitable SLOTs and get on the waitlist in order to be able to obtain needed SLOTs.

17)   Step - "Asking for a meeting of the Coordination Committee", during this step if the airline is dissatisfied with the response from the coordinator to its SLOTs request, then it may ask for a meeting of the Coordination Committee to seek to resolve the situation.

18)   Step - "Committee made a decision in airline favor", during this step coordination committee consider all facts regarding airline asking and make a decision.

Depending on committee decision airline may require SLOTs confirmation or performs schedule changes.

19)   Step - "Confirmed arrival SLOTs", during this step department responsible for obtaining airport SLOTs have to check existence of confirmed SLOTs for the destination airport.

20)   Step - "Time restrictions concerning the flight", during this step responsible department have to check existence of any restrictions in the arrival airport for the time period that would be needed to operate the flight.

21)   Step - "Historical rights for SLOTs", during this step responsible department have to check availability of historical rights priority for the airport SLOTs at the arrival airport.

22)   Step - "Requesting SLOTs with the historical rights priority", during this step if the operator has historical priority for the airport SLOTs responsible department have to send request for the airport SLOTs to the airport coordinator based on historical rights.

23)   Step - "Receiving SLOTs confirmation", during this step department responsible for obtaining airport SLOTs have to receive confirmation of request from the airport coordinator.

24)   Step - "Checking requirements for SLOTs request", during this step responsible department have to check additional requirements and procedures for SLOTs request set by the state and/or airport authorities, and satisfy them.

25)   Step - "Requesting SLOTs", during this step if there are no historical rights responsible department have to send request for the airport SLOTs to the airport coordinator on general terms.

26)   Step - "Confirmation of SLOTs", during this step the airport coordinator processes request and defines ability of the airport to handle the flight at the specified time, and then, depends on ability, sends confirmation or offer for another SLOTs to the operator.

27)   Step - "Receiving offer from coordinator", during this step department responsible for obtaining airport SLOTs in case of refusal from coordinator have to

check offer and transfer information for processing to the department responsible for the schedule.

28) Step - "Discussion of an offer", during this step department responsible for the schedule have to discuss possibility to change the schedule.

29) Step - "Offered SLOTs suit for flight", during this step department responsible for the schedule have to define suitability of the airport SLOTs offered by the coordinator to operate flight.

30) Step - "Confirming the offer", during this step department responsible for obtaining airport SLOTs have to send confirmation of the offer to the airport coordinator.

31) Step - "New entrant status", during this step defines availability of new entrant status of the airline.

32) Step - "Status priority missed", during this step if the airline requested SLOTs with new entrant status or another priority status, responsible unit defines coordinator violations during distribution of the SLOTs. The airline may ask for a committee meeting depending on whether there have been any violations.

33) Step - "Accepting the best offer with pending request time", during this step aircraft operator can not accept SLOTs offered by the coordinator. Responsible unit have to define the most suitable SLOTs and inform department responsible for obtaining airport SLOTs. Department responsible for obtaining airport SLOTs have to send confirmation of the most suitable SLOTs and get on the waitlist in order to be able to obtain needed SLOTs.

34) Step - "Asking for a meeting of the Coordination Committee", during this step if the airline is dissatisfied with the response from the coordinator to its SLOTs request, then it may ask for a meeting of the Coordination Committee to seek to resolve the situation.

35) Step - "Committee made a decision in airline favor", during this step coordination committee consider all facts regarding airline asking and make a decision. Depending on committee decision airline may require SLOTs confirmation or performs schedule changes.

36)   Step - "Confirming schedule coordination", during this step responsible unit have to confirm that all airport SLOTs for the flight have been obtained and schedule coordinated.

CONCLUSION TO CHAPTER 2

In the second chapter, based on theoretical data about the basic concepts of algorithms, as well as an analysis of existing procedures for obtaining airport slots from the first chapter, 2 action algorithms were formulated to obtain airport slots. Algorithm of airport slots coordination for charter flights and algorithm of airport slots coordination for scheduled flights. These 2 algorithms show us that even a very well thought out concept of airport slots is not ideal and has its drawbacks.

This conclusion can be drawn from a more detailed consideration of the algorithms. The algorithm of airport slots coordination for charter flights consists of 22 stages and the algorithm of airport slots coordination for scheduled flights consists of 16 stages.

In these algorithms, 9 and 16 points, respectively, completely duplicate each other. In real life, performing the same coordination actions with different airports is very time consuming and makes this coordination less effective. To improve the existing procedures as well as improvements of other elements, I have worked out a centralized airport SLOTs allocation system which can be found in the next chapter.

CHAPTER 3

CONCEPT OF CENTRALIZED AIRPORT SLOTS ALLOCATION SYSTEM

3.1   Statistical data of the aviation industry in Ukraine

Aviation industry takes one of the leading spaces in terms of development rate. Each year new and new air carriers enter the market, new airports building, aircrafts creating and modernizing, and technologies are aimed to automate many processes. In order to correct understanding of new tendencies in industry and choosing the right way to develop infrastructure and systems, we need to analyze statistical data regarding the activities of airports, air carriers, etc.

3.1.1   Statistics for 2018

Statistics on the activities of the aviation industry in 2018 indicate its stable development. Thus, during the reporting year, 34 Ukrainian airlines carried passengers, cargo and mail, which performed 100.3 thousand commercial flights (in 2017 - 93 thousand flights). At the same time, the number of transported passengers increased compared to 2017 by 18.7 percent and amounted to 12,529 thousand people, the volume of cargo and mail by air of Ukraine increased by 19.7 percent and amounted to 99.1 thousand tons. Since 2016, the market for passenger air transportation has developed quite dynamically. Thus, the number of passengers who used the services of Ukrainian airlines grew by an average of a quarter every year. Gradually, in three years, the volume of passenger traffic has almost doubled compared to 2015. [2].

Passenger transportation was carried out by 21 Ukrainian airlines, among which the leading position was occupied by the airlines "International Airlines of Ukraine", "Wind Rose", "Azur Air Ukraine", "Yanair" and "Bravo". By the end of the year, the five largest passenger airlines transported 11,620.6 thousand people, which is 20.2 percent more than in 2017 and is almost 93 percent of the total passenger traffic of Ukrainian airlines. More than half (54.2 percent) of all passenger traffic of Ukrainian airlines are international scheduled services. In 2018, according to the approved schedule, regular international flights were operated by 10 Ukrainian airlines to 46

countries, the number of passengers who used the services of Ukrainian air carriers increased by 16.4 percent and amounted to 6796.2 thousand people. Simultaneously with the increase in the intensity of flights in many mastered areas, the network of routes of Ukrainian airlines developed. Thus, during the year, Ukrainian airlines opened 17 new scheduled routes. At the same time, the average employment rate of passenger seats on international scheduled flights of Ukrainian airlines increased from 77.7% in 2017 to 78.8% in the reporting year. [2].

At the same time, there was an expansion of activities in the Ukrainian market of foreign airlines, 5 new foreign airlines started regular flights to Ukraine. The 2018 was also marked by the development of the route network of foreign airlines, which started operating 27 international airlines. In total, in 2018, 38 foreign airlines from 37 countries flew to our country. Their services were used by 6,857.3 thousand passengers, which is 37.8 percent more than in 2017 and accounts for 50.2 percent of the total volume of regular passenger traffic between Ukraine and the world. Significant growth (by 23.1 percent) was observed in such a sector of the passenger air transportation market as international flights on an irregular basis, during the reporting period 16 Ukrainian airlines carried 4,649.9 thousand passengers. At the same time, almost 84 percent of such flights were carried out by the five above-mentioned leading airlines.

During the year, the intensification of regular transportation within Ukraine continued. Domestic passenger traffic was performed regularly by four Ukrainian airlines, which provided air services to ten cities of Ukraine. During the reporting year, 1,071.4 thousand air passengers were transported, which is 15.1 percent more than in the previous 2017. At the same time, the average employment rate of passenger seats on domestic scheduled flights increased from 73.5% in 2017 to 79.3% in 2018. [4].

Also, 22 Ukrainian airlines performed cargo and mail transportation. It should be noted that most cargo has traditionally been charter flights to other countries under UN humanitarian and peace programs, as well as under contracts and agreements with other customers. The leaders of traffic are SE "Antonov" (growth compared to 2017 by 15.3 percent), the airline "International Airlines of Ukraine" (growth - by 10.2 percent),

"ZetAvia" (growth - by 36.8 percent), "Maximus Airlines" (growth - 2.2 times). These airlines performed 78 percent of the total cargo and mail traffic in the reporting period. For better comprehension statistics data of all flights performed within territory of Ukraine during 2018 collected in table 3.1.

Table 3.1 - Intensity of air traffic in Ukraine in 2018

Performed flights	Quantity
Transit flights	125 145 flights
International flights by Ukrainian airlines	77 443 flights
International flights by foreign airlines	68 672 flights
Domestic flights	29 593 flights
Total	300 853 flights

Commercial flights of Ukrainian and foreign airlines served 20 Ukrainian airports and airfields, during the reporting period the total number of departing and arriving aircraft amounted to 182.8 thousand units, which is 14.3 percent more than in 2017. At the same time, passenger traffic through the airports of Ukraine, exceeding the 20 million mark, reached 20,545.4 thousand people, which increased by 24.5 percent. Freight traffic increased by 7.8 percent and amounted to 56.4 thousand tons. According to statistics for 2018, there was a significant increase in the number of passengers served at all major airports: Kyiv (Zhulyany) (by 51.9 percent), Lviv (by 47.9 percent), Boryspil (by 19.4 percent), Kharkiv (by 19.3 percent), Odesa (by 17.8 percent), Zaporizhia (by 14.9 percent) and Dnipropetrovsk (by 8.1 percent). Also, a significant increase in passenger traffic was recorded at the airports of Chernivtsi (by 53 percent) and Kherson (by 41.8 percent). It should be noted that today almost 98 percent of total passenger traffic and 99 percent of mail and cargo traffic are concentrated in 7 airports in the country - Boryspil, Kyiv (Zhulyany), Lviv, Odesa, Kharkiv, Zaporizhia, and Dnipropetrovsk. [2].

Share of passenger traffic at airports of Ukraine

● Kyiv Boryspil   ● Kyiv Zhulyany   ● Lviv   ● Odesa   ● Kharkiv   ● Other

Figure 3.1 – Share of passenger traffic at airports of Ukraine in 2018

Most of the traffic still takes place through central airports, as can be seen from figure 3.1, but regional airports also have a share of traffic.

3.1.2 Statistics for 2019

During 2019, passenger and cargo transportation was carried out by 29 Ukrainian airlines, which performed a total of 103.3 thousand commercial flights (in 2018 - 100.2 thousand flights). In 2019, the passenger air transportation market continued to show positive dynamics. According to statistics, the number of passengers who used the services of Ukrainian airlines increased by 9.4 percent and amounted to 13,705.8 thousand people. Passenger traffic during the year was provided by 18 Ukrainian airlines, among which the largest volumes were performed by Ukraine International Airlines, Azur Air Ukraine, SkyUp, Wind Rose, and Bukovyna. During the reporting year, the five leading airlines transported a total of 13,306.7 thousand people, which is 22.4 percent more than in 2018 and is 97 percent of the total passenger traffic of Ukrainian airlines. [3].

More than half (51.9 percent) of all passenger traffic Ukrainian airlines are international scheduled services. In 2019, according to the approved schedule, 10

Ukrainian airlines to 46 countries of the world carried out regular international passenger traffic. The number of passengers who used Ukrainian services companies, increased by 4.6 percent and amounted to 7107.2 thousand people, while the average percentage of passenger traffic on international scheduled flights increased by 2.1 percentage points and amounted to 80.9%. The network of routes of Ukrainian air carriers, which started operating regularly of 17 international airlines, continued to develop. According to the results of 2019, the largest growth rate (16.9 percent) of the number of passengers carried by Ukrainian airlines was observed in such a market segment as international flights on a non-scheduled basis. During the year, 16 Ukrainian airlines transported 5,440,000 passengers. At the same time, almost 97 percent of such flights are operated by the five above-mentioned leading airlines. [5].

Also, there was an expansion of activities in the Ukrainian market of foreign airlines, which used 9422.5 thousand passengers, which is 37.4 percent higher than in 2018 and is 57 percent of the total volume of regular passenger traffic between Ukraine and the world. In total, regular foreign flights to Ukraine were operated by 40 foreign airlines (including four new ones - the Austrian airline Laudamotion, the French Aigle Azur (operated until September 2019), the Israeli Israir Airlines, and the Norwegian Scandinavian Airlines System). 37 countries. During the year, 29 new routes were opened by foreign airlines, including 21 new routes by Ryanair and Wizz Air Hungary.

Regular domestic passenger traffic between 11 cities of Ukraine was performed by four Ukrainian airlines ("International Airlines of Ukraine", "Motor Sich", "Wind Rose" and "SkyUp"). During 2019, 1,145.2 thousand passengers were transported by regular flights within Ukraine, which is 6.9 percent more than in the previous year. At the same time, the average percentage of passenger traffic on domestic scheduled flights of Ukrainian airlines was 75.9% (against 79.3 in 2018), and in 2020, passenger traffic at regional airports has grown even more thanks to the launch of a large network of domestic flights. All data will be provided by civil aviation authorities and can be compared with the indicators of previous years. Statistics data of all flights performed within territory of Ukraine during 2018 collected in table 3.2. Also all statistic about industry activity collected in table 3.3.

Table 3.2 - Intensity of air traffic in Ukraine in 2019

Performed flights	Quantity
Transit flights	141 680 flights
International flights by Ukrainian airlines	80 077 flights
International flights by foreign airlines	82 860 flights
Domestic flights	30 790 flights
Total	335 407 flights

The State Air Traffic Service of Ukraine (UkSATSE) for the reporting year served 335.4 thousand flights against 300.9 thousand in 2018 (traffic growth by 11.5%), which is 63% of the volume of 2013. One-third of the flights were operated by Ukrainian airlines. In 2019, the number of flights operated by planes and helicopters of Ukrainian airlines increased by 2.9 percent, foreign airlines - by 16.2 percent. A significant part of traffic growth is provided by the development of Ukraine's international airports, the volume of domestic traffic and flights exceeded the level of 2013 by 6%.

Table 3.3 - Intensity of air traffic in Ukraine during 2015-2019

Year	2015	2016	2017	2018	2019
Transit flights	117 487	86 290	101 755	125 145	141 680
International flights by Ukrainian airlines	47 758	58 448	70 776	77 443	80 077
International flights by foreign airlines	47 746	46 087	54 962	68 672	82 860
Domestic flights	21 870	23 407	26 476	29 593	30 790
Total	234 861	214 262	253 969	300 853	335 407

From the table 3.1 we can see positive dynamic in aviation industry in Ukraine, and even after descent of activity like in 2016 industry easy returns to growth.

In total, commercial flights of Ukrainian and foreign airlines in 2019 served 19 Ukrainian airports and airfields. The number of aircraft sent and arrived during the year amounted to 201.2 thousand. (against 182.8 thousand for the previous year). At the same time, passenger traffic through the airports of Ukraine increased by 18.4 percent and reached 24,334.5 thousand people. Freight traffic increased by 6.7 percent and amounted to 60.2 thousand tons. At the same time, about 98 percent of passenger traffic and almost all mail and cargo flows are concentrated in 7 major airports (Boryspil, Kyiv (Zhulyany), Lviv, Odesa, Kharkiv, Zaporizhia, and Dnipropetrovsk). The increase in the number of passengers served compared to 2018 was recorded at the following airports: Kharkiv - by 39.4 percent, Lviv - by 38.8 percent, Boryspil - by 21.1 percent, Dnipropetrovsk - by 13.2 percent, Odesa - by 17, 1 percent and Zaporizhia - by 8.4 percent. [3].

Share of passenger traffic at airports of Ukraine

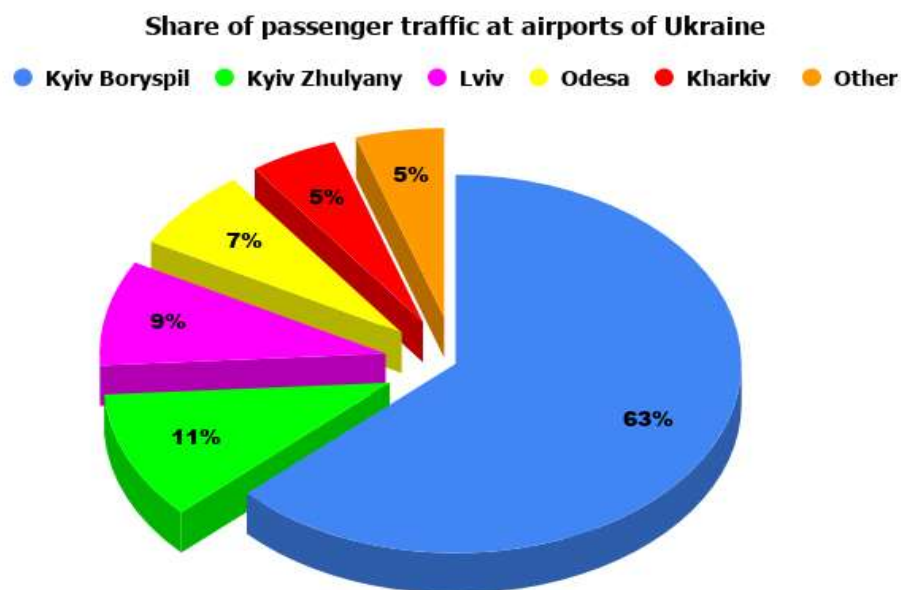● Kyiv Boryspil   ● Kyiv Zhulyany   ● Lviv   ● Odesa   ● Kharkiv   ● Other

Figure 3.2 – Share of passenger traffic at airports of Ukraine in 2019

After comparison of share of passenger traffic at airports of Ukraine in 2018 and 2019, we can see that portion of the traffic in regional airports almost not increased. It means that Ukrainian regional airports are not attractive for air carriers. Different requirements for schedule coordination in regional airports also influence the decision of air carriers to perform flights only to central airports.

3.2   Centralized airport slots allocation system description

Based on the statistics in point 3.1, we see that despite the crises, the aviation industry continues to develop. Air carriers very quickly restore and increase the volume of traffic. In Ukraine, more than 60% of air traffic is concentrated in central airports because it is not profitable for both Ukrainian and foreign airlines to fly to regional airports. There are many reasons for the low number of flights to regional airports, among them the lack of passenger traffic, poor infrastructure, completely different requirements for operators at different airports, etc.

Despite the crisis of 2020 in the aviation industry, the Ukrainian airline "Windrose" launched a large-scale project and created a large network of domestic flights. For this, modernization was carried out to increase the attractiveness of airports, improve infrastructure, and so on. Passenger traffic has also appeared in regional airports, which can attract foreign airlines. However, the issue of regulating the procedures for coordinating the schedule at different airports remains open. Nowadays, in order to achieve a result, we need to be proactive, and now the necessity to agree on different procedures at different airports is not a serious obstacle, but in the future, it can bring great inconvenience to air carriers and reduce the attractiveness of airports.

In order to unify the procedures for coordinating the schedule and services with airports, I have worked out the concept of "Centralized airport SLOTs allocation system" for Ukraine. The concept is a private and\or state enterprise whose task will be:

- to coordinate the schedule and\or airport slots,
- resolve issues between aircraft operators and airport authorities, and
- receive and process applications for aircraft handling at all airports of Ukraine according to uniform standards and procedures.

This system may not be limited to the territory of one country, but unite several countries into a single system for coordinating the schedule and\or airport slots. For example 3 neighboring states can create centralized system.

Centralized airport slots allocation system includes two main units, "Airport unit" and "Coordination center", and managing unit. The airport unit is a center at the airport that transmits information about:

- performed flights,
- available infrastructure such as tugs, buses for passengers, etc. (all that is needed to handle the flights),
- monitor the regularity of flights, and
- observes violations of both aircraft operators and the airport authorities.

Airport unit is necessary local airport center that independently from airport authorities can observe the quality of airport services and airlines, and intervene if necessary.

Coordination center is the authority that, based on information received from the airport unit:

- create a pool of airport slots,
- accepts applications from aircraft operators,
- coordinates the schedule and/or airport slots,
- select the most suitable time for the flight at airports base on requests,
- assigns a priority status to airlines for the schedule and/or airport slots coordination, and
- resolves controversial issues.

Having all the necessary information about the condition of airports and their capacity, the coordination center will conduct more efficient and accurate coordination between the airport and the airline through effective management of requests and suitable offers for aircraft operators.

This will speed up and improve the quality of the aviation services at all. In general, the system will be similar to the existing separate coordination centers at different airports, but it will have the main advantage, namely, unified rules of schedule and /or airport slots coordination at all airports that are part of the unified coordination system.

I divided the process of creating a system into 5 main phases:

1)   System design phase includes:

- determination of the form of the enterprise, state and/or private,

- creation of a legal framework,

- creation and adoption of a law on the approval of the system.

2)   Creation of the managing unit phase includes:

- establishment of the managing unit following the legal framework about the centralized system,

- recruitment of personnel following the legal framework.

3)   Development of procedures and requirements phase includes:

- development of procedures for centralized coordination by managing unit,

- development of requirements for centralized coordination by managing unit,

- establishment of these procedures and requirements by local civil aviation authority or authorities.

4)   Creation of the coordination center and the airport units phase includes:

- establishment of the coordination center under legal framework about the centralized system,

- establishment of the airport units under the legal framework,

- recruitment of personnel under the legal framework.

5)   System introduction phase includes:

- starting the centralized airport slots allocation system in test mode to identify all the weak points,

- fixing all weak points,

- full implementation of the new centralized airport slots allocation system for coordination between the airports and the air operators.

If necessary, additional items can be added to all phases of the system creation if required.

According to IATA regulations, slots coordination is required only in the level 3 airports, therefore special messages, for example, SCR, can be used only for slots coordination. Centralized airport slots allocation system provides a mandatory system of messages originally assigned for slots coordination for all types of coordination in the airports that are included in the system. This will allow us to reduce the number of schedule coordination procedures and reduce the time spent on processing the application by the center coordinator. Therefore, regardless of the level of the airport, requests for schedule and\or slots coordination will be similar.

3.3 Algorithm of airport slots coordination with centralized airport SLOTs allocation system for charter flights

All structural algorithms of the centralized airport slots allocation system are the general graphical description of airport slots coordination procedures with the usage of a centralized system. These algorithms can be used as a basis for the creation of the airport slots obtaining procedure with the centralized system. During the creation of these algorithms, the main task was the simplification of existing procedures of airport slots coordination.

The algorithms of coordination with centralized airport slots allocation system do not include procedures for interaction between different units of this system. All procedures for internal interaction in the system should be created separately taking into account the existing experience of interaction within the coordination centers of airports. Also, when creating new requirements and procedures, it is necessary to take the standards and recommended practices of IATA and ICAO as a legal basis for the system to be recognized at the international level.

The algorithm of airport slots coordination with centralized airport slots allocation system for charter flights consist of 11 steps, not including "start" and "end" stages, and shown in figure 3.3 further. This algorithm is a branched type algorithm with several cycle steps. The textual description of the algorithm fully describes each stage for a better understanding of the process.
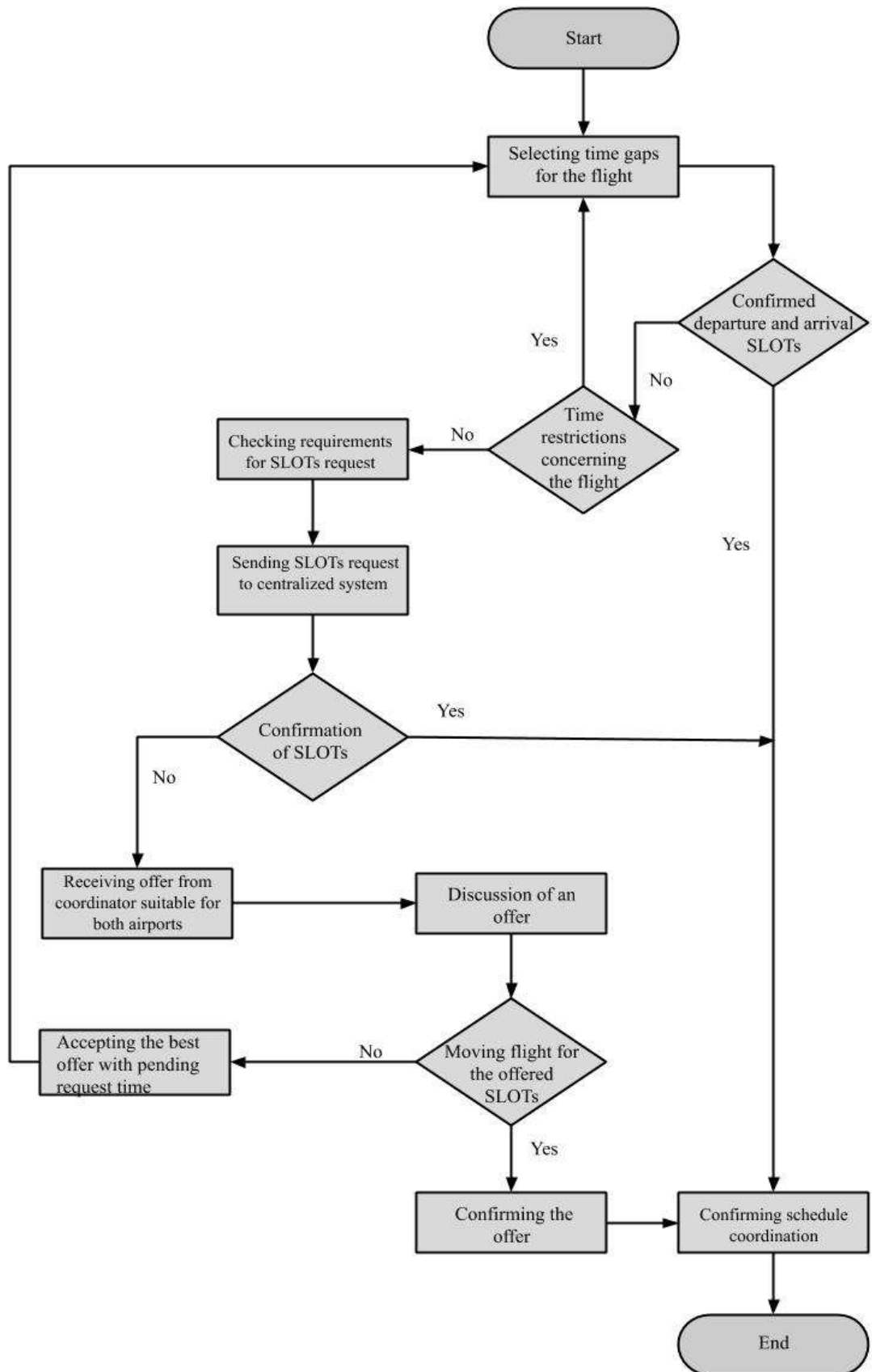
Figure 3.3 - Algorithm of airport slots coordination with centralized airport SLOTs allocation system for charter flights

Algorithm description:

1) Step - "Selecting time gaps for the flight", during this step department of the aircraft operator responsible for the schedule decided at what time operator have to perform the flight or discuss essential changes in the schedule.

2) Step - "Confirmed departure and arrival SLOTs", during this step department responsible for obtaining airport SLOTs have to check existence of confirmed SLOTs for the origin and the destination airport.

3) Step - "Time restrictions concerning the flight", during this step responsible department have to check existence of any restrictions in the departure and arrival airports for the time period that would be needed to operate the flight.

4) Step - "Checking requirements for SLOTs request", during this step responsible department have to check additional requirements and procedures for SLOTs request set by the state and/or centralized airport SLOTs allocation authorities, and satisfy them.

5) Step - "Sending SLOTs request to centralized system", during this step responsible department have to send request for the airport SLOTs in both airports to the centralized airport SLOTs allocation system coordinator.

6) Step - "Confirmation of SLOTs", during this step the centralized airport SLOTs allocation system coordinator processes request and defines ability of the both departure and destination airports to handle the flight at the specified time, and then, depends on ability of the airports, sends confirmation or offer for another SLOTs to the operator. SLOTs offer should contain options for both airports and also take into account block time of the flight(s).

7) Step - "Receiving offer from coordinator suitable for both airports", during this step department responsible for obtaining airport SLOTs in case of refusal from coordinator have to check offer for both airports and transfer information for processing to the department responsible for the schedule.

8) Step - "Discussion of an offer", during this step department responsible for the schedule have to consider all options in the both airports and discuss possibility to move the schedule to get into the offered SLOTs.

9)   Step - "Moving flight for the offered SLOTs", during this step department responsible for the schedule have to decide to move or not the schedule to get into the offered SLOTs.

10)   Step - "Confirming the offer", during this step department responsible for obtaining airport SLOTs have to send confirmation of the offer for both airports to the centralized airport SLOTs allocation system coordinator.

11)   Step - "Accepting the best offer with pending request time", during this step aircraft operator can not accept SLOTs offered by the coordinator. Responsible unit have to define the most suitable SLOTs in both airports and inform department responsible for obtaining airport SLOTs. Department responsible for obtaining airport SLOTs have to send confirmation of the most suitable SLOTs and get on the waitlist in order to be able to obtain needed SLOTs. Also in this case operator need to clarify information with coordinator about opportunity to swap SLOTs with another operator.

3.4   Algorithm of airport slots coordination with centralized airport SLOTs allocation system for scheduled flights

All coordination for schedule flights must be completed in accordance to IATA calendar of coordination. This means that managing unit of centralized airport slots allocation system have to make sure that all applications are submitted on time according to the calendar.

Although the system is an autonomous body and does not depend on international organizations, the fulfillment of their requirements and recommendation practices is necessary to simplify procedures and obtain support from international organizations such as IATA or ICAO.

The algorithm of airport slots coordination with centralized airport slots allocation system for charter flights consist of 19 steps, not including "start" and "end" stages, and shown in figure 3.4 further. This algorithm is a branched type algorithm with several cycle steps. The textual description of the algorithm fully describes each stage for a better understanding of the process.
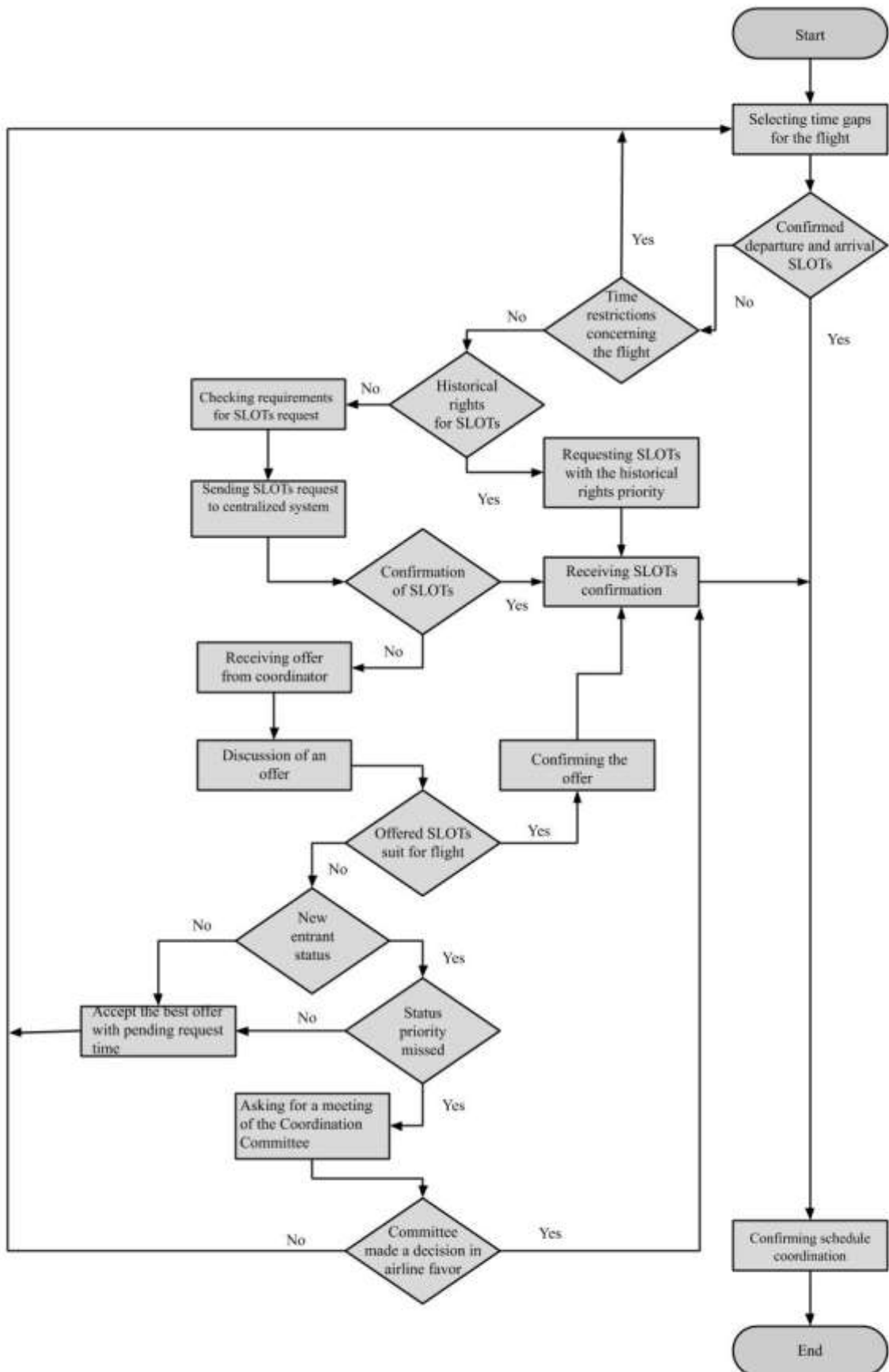
Figure 3.4 - Algorithm of airport slots coordination with centralized airport SLOTs allocation system for scheduled flights

Algorithm description:

1) Step - "Selecting time gaps for the flight", during this step department of the aircraft operator responsible for the schedule decided at what time operator have to perform the flight or discuss essential changes in the schedule.

2) Step - "Confirmed departure and arrival SLOTs", during this step department responsible for obtaining airport SLOTs have to check existence of confirmed SLOTs for the origin and the destination airport.

3) Step - "Time restrictions concerning the flight", during this step responsible department have to check existence of any restrictions in the departure and arrival airports for the time period that would be needed to operate the flight.

4) Step - "Historical rights for SLOTs", during this step responsible department have to check availability of historical rights priority for the airport SLOTs at both departure and destination airports.

5) Step - "Requesting SLOTs with the historical rights priority", during this step if the operator has historical priority for the airport SLOTs responsible department have to send request for the airport SLOTs in both airports to the centralized airport SLOTs allocation system coordinator.

6) Step - "Receiving SLOTs confirmation", during this step department responsible for obtaining airport SLOTs have to receive confirmation of request from the coordinator.

7) Step - "Checking requirements for SLOTs request", during this step responsible department have to check additional requirements and procedures for SLOTs request set by the state and/or centralized airport SLOTs allocation authorities, and satisfy them.

8) Step - "Sending SLOTs request to centralized system", during this step responsible department have to send request for the airport SLOTs in both airports to the centralized airport SLOTs allocation system coordinator.

9) Step - "Confirmation of SLOTs", during this step the centralized airport SLOTs allocation system coordinator processes request and defines ability of the both departure and destination airports to handle the flight at the specified time, and then,

depends on ability of the airports, sends confirmation or offer for another SLOTs to the operator. SLOTs offer should contain options for both airports and also take into account block time of the flight(s).

10) Step - "Receiving offer from coordinator suitable for both airports", during this step department responsible for obtaining airport SLOTs in case of refusal from coordinator have to check offer for both airports and transfer information for processing to the department responsible for the schedule.

11) Step - "Discussion of an offer", during this step department responsible for the schedule have to consider all options in the both airports and discuss possibility to move the schedule to get into the offered SLOTs.

12) Step - "Offered SLOTs suit for flight", during this step department responsible for the schedule have to define suitability of the airport SLOTs offered by the coordinator to operate flight.

13) Step - "Confirming the offer", during this step department responsible for obtaining airport SLOTs have to send confirmation of the offer for both airports to the centralized airport SLOTs allocation system coordinator.

14) Step - "New entrant status", during this step defines availability of new entrant status of the airline.

15) Step - "Status priority missed", during this step if the airline requested SLOTs with new entrant status or another priority status, responsible unit defines coordinator violations during distribution of the SLOTs. The airline may ask for a committee meeting depending on whether there have been any violations.

16) Step - "Accepting the best offer with pending request time", during this step aircraft operator can not accept SLOTs offered by the coordinator. Responsible unit have to define the most suitable SLOTs and inform department responsible for obtaining airport SLOTs. Department responsible for obtaining airport SLOTs have to send confirmation of the most suitable SLOTs and get on the waitlist in order to be able to obtain needed SLOTs.

17) Step - "Asking for a meeting of the Coordination Committee", during this step if the airline is dissatisfied with the response from the coordinator to its SLOTs

request, then it may ask for a meeting of the Coordination Committee to seek to resolve the situation.

18) Step - "Committee made a decision in airline favor", during this step coordination committee consider all facts regarding airline asking and make a decision. Depending on committee decision airline may require SLOTs confirmation or performs schedule changes.

19) Step - "Confirming schedule coordination", during this step responsible unit have to confirm that all airport SLOTs for the flight have been obtained and schedule coordinated.

3.5 Comparative characteristics of obtaining airport slots in coordination with separate airport coordination centers and the coordination center of a centralized system

For comparison, we will take two algorithms for getting airport slots for regular flights. Figure 3.5 highlights a fragment of an algorithm based on existing procedures that can be removed during operation with centralized airport SLOTs coordination system.
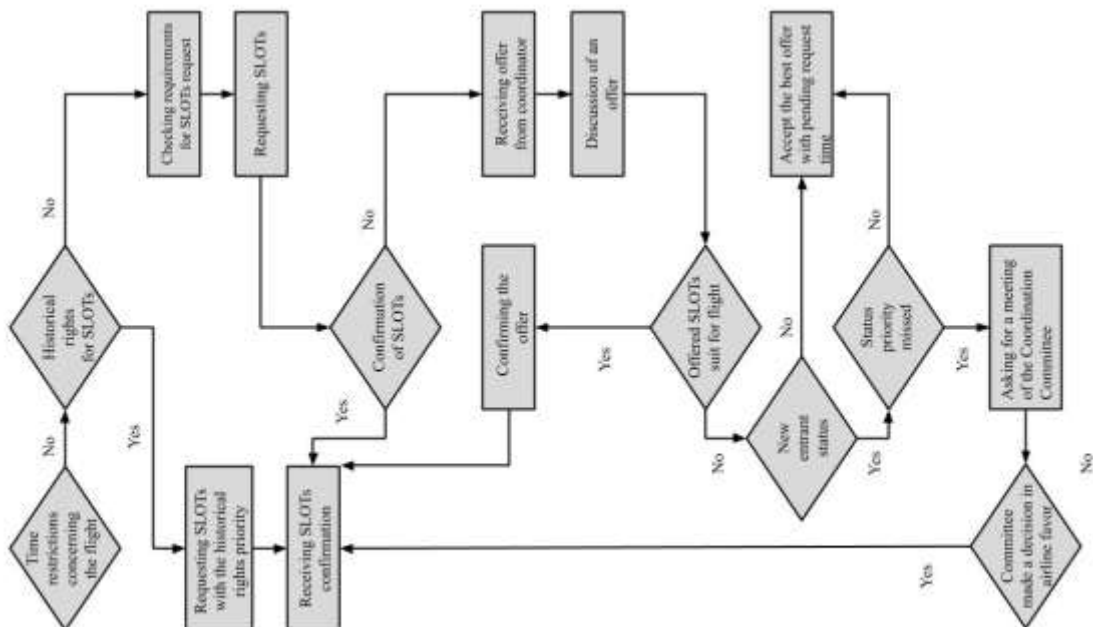

Figure 3.5 - Fragment of algorithm of airport SLOTs coordination for scheduled flights

This fragment takes half the steps for obtaining airport slots under the existing coordination procedures with separate airport coordination centers. In coordination with a single coordination center, all questions on the selection of suitable slots, if it is impossible to provide the aircraft operator with the requested slots, go to the coordination center. In this case, the aircraft operator will not just take a place on the waiting list and will get the most suitable time to perform its flights. From these data, we can conclude that a centralized system will be much more efficient in managing the distribution of airport slots with an increase in air traffic.

CONCLUSION TO CHAPTER 3

Based on the statistics given in point 3.1, we see that despite the crisis, the aviation industry continues to develop. Operators are increasing the volume of air traffic both on international and domestic routes. To improve the existing procedures and algorithms for obtaining airport slots, point 3.2 describes the concept of centralized airport SLOTs allocation system.

After analyzing all the elements of the centralized system as anticipated future procedures for obtaining airport slots, I have drawn up algorithms for coordinating airport slots with a single center. In a comparative analysis of two algorithms, namely algorithm of airport slots coordination with centralized airport SLOTs allocation system for scheduled flights and algorithm of airport SLOTs coordination for scheduled flights which are shown in figures 3.4 and 2.5, respectively we concluded that the centralized system shows itself more efficiently by reducing the coordination time by 2 times.

GENERAL CONCLUSIONS

Obtaining airport slots is one of the most time-consuming processes in air transportation organization. Given the current trends in the development of the aviation industry, this stage requires improvement. After analyzing all the theoretical bases of the existing procedures for obtaining airport slots, the concept of the centralized airport SLOTs allocation system was proposed.

Centralized airport SLOTs allocation system will be responsible for the optimization of the capacities available at airports on Ukraine territory in order to avoid congestion, delays, and to obtain the best possible use of the available airport capacity.

The slot coordination and schedules facilitation service will be provided to airlines and airports in a neutral, transparent, and non-discriminatory manner, aim at achieving the optimum use of capacity at congested airports. Centralized airport SLOTs allocation system will be also responsible for monitoring compliance of the slots allocated and schedules facilitated, in cooperation with the airports and the air navigation authorities.

In addition, this system is designed to unify the procedures for coordinating the schedule in regional airports to increase their attractiveness for both Ukrainian and international airlines and to help resolve disputes as an independent body.

The aviation industry is the most harmonized in the world because organizations like ICAO and IATA create uniform rules and best practices for all. Centralized airport SLOTs allocation system with all of the above-mentioned advantages will make a huge contribution to the development of the aviation industry.

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