Working Paper 1

Performance of the Current Airport Slot Allocation Process and Stakeholder Analysis Report

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Executive summary

Among the different modes of transport, air transport has experienced the fastest growth over the last years. Most major airports in Europe suffer of capacity shortage due to several reasons. As building new facilities is not always possible, the expansion of air service relies upon improvements in ATC technology and implementation of new procedures. These improvements have provided great increases in capacity, but this is still insufficient to cope with air traffic demand at the most congested airports, and it thus has to be accompanied by other measures for the management of scarce capacity. The European approach to the strategic allocation of airport capacity is an administrative slot allocation system inspired by IATA Guidelines.

Airport slot allocation at EU airports is governed globally by the IATA Worldwide Slot Guidelines and within the European Union by Regulation 95/93 and its respective amendments Regulation 894/2002, Regulation 1554/2003, Regulation 793/2004 and Regulation 545/2009. A "slot" is defined as "the permission given by a coordinator in accordance with this Regulation to use the full range of airport infrastructure necessary to operate an air service at a coordinated airport on a specific date and time for the purpose of landing or take-off as allocated by a coordinator in accordance with this Regulation". The coordinators are responsible for assigning slots applying the regulation. Coordinators and airspace users meet at biannual IATA conferences, where bilateral negotiations are carried out and slot assignment is negotiated. The main criteria applied for airport slot allocation is historical precedence: airlines can earn historic rights (the so-called grandfather rights) to a series of slots, provided they operate the slots as allocated by the coordinator at least 80% of the time during a season (use-it-or-lose-it rule, also called 80-20 rule).

The European Commission proposed a way forward with regulation proposal COM 2011/827. This proposal introduces deep changes in the current system: secondary trading is explicitly accepted, use-it-or-lose-it rule is tightened, rules are reformed to help new entrants access the market at congested airports and rules on the independence of the coordinator are also tightened.

The stakeholders involved in airport slot allocation can be classified into four groups: regulators, airport coordinators, airspace users and airport operators. Each of them plays a role in the system and has its own interests. Airspace users group is quite heterogeneous, since it is composed by several types of stakeholders, with different strategies. Stakeholder's preference and positioning regarding market-based mechanisms depend on their interests and business strategies. Their positioning ranges from being satisfied with the current regulation and thus not supporting any changes, to favouring the change of several principles (e.g. increase the use-it-or-lose-it rule). The proposal that arouses more consensus is the regulation of secondary slot trading.

A comprehensive assessment of different potential reforms of the slot system should develop a better understanding of the economic value of each slot, evaluate the effects of such reforms along different dimensions (economic efficiency; equity; access and competition; flexibility; resilience and adaptability; interoperability; capacity and delay) and analyse their impact on the different stakeholders involved.

1. Introduction

1.1 Scope and objectives

The main objective of this document is to establish a solid baseline regarding the performance of the current airport slot allocation system and the characterisation of the stakeholders involved.

The document is expected to meet a number of lower level objectives:

1. To perform a review of the current slot allocation process, including the observed practices and legislative framework set by the Regulation (EEC) 95/93, as amended by Regulation (EC) 793/2004.

2. To identify the potential for improvement offered by the EC legislative proposal COM/2011/0827:

   - slot trading among airlines anywhere in the EU in a transparent way;
   - access of new entrants to congested airports;
   - rules requiring airlines to demonstrate slot usage;
   - independence of the coordinator and transparency on slots transactions;
   - information flows between stakeholders in order to inform decision making;

3. To provide a framework for the design and development of market-based mechanisms for airport slot allocation, in terms of:

   - roles and responsibilities;
   - rules, principles and challenges;
   - expectations and positions from stakeholders.

1.2 Structure of the document

The document is structured as follows:

- Section 2 describes the current airport slot allocation mechanism. It first describes and analyses the applicable European regulation within the framework of the universally applicable IATA guidelines, evaluates the worldwide scope of the problem, compiles and analyses examples of current slot exchanges, and analyses airport slot allocation systems adopted in other regions of the world.
- Section 3 evaluates the performance of the current system, based on the description of its advantages and drawbacks in relevant performance areas: economic efficiency; equity and distributional issues; access and competition, flexibility, resilience and adaptability; interoperability; and capacity and delay. It also describes the way forward proposed by the European Commission on airport slot allocation.
- Section 4 analyses the stakeholders involved in the airport slot allocation process, describing their roles and responsibilities as well as their preferences and position regarding the implementation of market-based mechanisms.
- Section 5 includes a synthesis of the main findings and the conclusions.

1.3 Acronyms and terminology

Term	Definition
AENA	Aeropuertos Españoles y Navegación Aérea
ACI	Airports Council International
AEA	Association of European Airlines
AER	Assembly of European Regions
ALG	Advanced Logistic Group
ATC	Air Traffic Control
ATM	Air Traffic Management
ATMs	Air Transport Movements
CFMU	Central Flow Management Unit
E-ATMS	European Air Traffic Management System
EBAA	European Business Aviation Association
EC	European Commission
EEC	European Economic Community
ERA	European Regions Airline Association
EU	European Union
EUACA	European Union of Airport Coordinators Association
FAA	Federal Aviation Association
GFR	Grandfather rights
IATA	International Air Transport Association
IBAC	International Business Aviation Council
IFR	Instrument Flight Rules
IMC	Instrument Meteorological Conditions
KPA	Key Performance Area
NOTAM	Notice to Airmen
PSO	Public Service Obligation
SARS	Severe Acute Respiratory Syndrome
SC	Slot Conference
SESAR	Single European Sky ATM Research Programme
SJU	SESAR Joint Undertaking (Agency of the European Commission)
UK	United Kingdom
VFR	Visual Flight Rules
WSG	IATA Worldwide Slot Guidelines

Table 1. Acronyms and terminology

2. The current airport slot allocation mechanism

Over the past decades, the overwhelming increase in air transport demand, in conjunction with severe political, physical and institutional constraints for providing sufficient airport capacity, have resulted in a serious gap between the demand and the available capacity at certain airports. A recent EUROCONTROL study [18] foresees around 1.9 million of un-accommodated flights in Europe in 2035, accounting for 12% of the demand.

Many major airports in Europe suffer from capacity shortage due to several reasons. Most European airports are still publicly controlled, which means they are dependent on political decisions and tight budgets. But even where such constraints apply less (as in the UK), expansion is restricted due to environmental limitations and other planning controls. Building new facilities, such as runways, is not an easy task. As a consequence, the expansion of air services relies mainly upon improvements in ATC technology and the development and implementation of new procedures to increase traffic in the already existing facilities. In the last decades, these improvements have provided great increases in capacity but, nevertheless, major airports are operating at, or close to, declared capacity for much of the day.

To respond to these needs, two main solutions can be adopted: to apply demand/congestion management or to implement capacity enhancement programs. Due to the complications for expanding existing airport capacity, demand management solutions have recently received much attention from researchers, operators and policy makers.

Airport demand management includes a wide spectrum of measures, ranging from pure administrative procedures, such as slot control according to regulations, to economic, market-based and hybrid instruments, such as congestion-based pricing, slot trading and auctions. Even though different studies have shown that administrative slot controls lead to inefficiencies and hinder competition [11], [40], slot control and schedule coordination have been so far the dominant approach in Europe.

2.1 Background

Two approaches predominate for the allocation of this capacity:

- Airport slot allocation: all the airlines that intend to schedule a flight movement to and from a coordinated airport need to be assigned an airport slot for this purpose. Most of the world outside the US allocates capacity according to a set of rules based on the guidelines set down by IATA. These guidelines are based on the recognition of the historical use of slots; an airline has the right to a slot if it has already made use of that slot during the preceding equivalent season. This historical precedence is commonly known as grandfather rights.
- Congestion: in the US, in contrast, the IATA-based system is not applied for most of the airports. Schedules are allocated on a first-come, first-served basis, and expected delays are calculated and taken into account by airlines in order to operate at the busiest airports. Aircraft wait to land or take-off in queues, rationing the overall demand. Although this is the general picture of the US airports, there are four which are an exception: Ronald Reagan Washington National airport and three

New York area airports (JFK, Newark, and La Guardia). At these airports the FAA prescribes the hourly number of flight operations and departure and arrival slots are assigned, loosely applying the IATA guidelines: the grandfather rule applies, but there is much that the national regulation imposes on the airport slot allocation process that is different. Slots can be bought and sold only at one airport; at the other three, only slot transfers between airlines are allowed.

A third possible rationing mechanism suggested in the literature, but with limited real application, is congestion pricing. Most proposals in this sense have involved setting an additional per-flight surcharge for operations at certain times of day. However, congestion charging is of difficult to implementation in practice. First, there are legal obstacles to such surcharges, since according to ICAO, aeronautical charges by airport operators must be set on a cost recovery basis. Conceptually one should get congestion charges to bring the level of scheduled operations in line with capacity, but this would require the calculation ex-ante of the relationship between prices and level of operations, which is a very difficult problem. Furthermore, surcharges would have the effect of shifting demand from one time window to another, making the price setting problem multi-dimensional.

2.1 Analysis of the current regulation

Airport slot allocation at EU airports is governed by Regulation 95/93 [12] and its respective amendments Regulation 894/2002, Regulation 1554/2003, Regulation 793/2004 and Regulation 545/2009 [23], [24], [25], [26], which retain and develop the principles of the IATA slot allocation process. There are also national or local laws in some countries imposing the rules that are sometimes more stringent.

From the four amendments of Regulation 95/93, only one of them (Regulation 793/2004) is a full revision of the regulation intended as a first step in a comprehensive revision process and focusing on a number of technical issues, notably:

- keep abreast of developments, in particular with respect to new entrants and market access issues;
- strengthen the Regulation 95/93 to ensure the fullest and most flexible use of limited capacity at congested airports;
- clarify a number of its provisions;
- follow the international terminology using the terms ‘schedules facilitated airport’ and ‘coordinated airport’ instead of ‘coordinated airport’ and ‘fully-coordinated airport’ respectively;
- specify in detail the role of the schedules facilitator and the coordination committee; and
- encourage regular operations at coordinated airports relating grandfather rights to series of slots.

The three other amendments to the regulation refer to mitigation actions taken due to specific events that impacted air transport operations:

- Regulation 894/2002: the terrorist attacks of 11th September 2001 in the United States and the political developments that followed those events seriously affected the operations of air carriers and resulted in a significant drop in demand during the remainder of the summer 2001 and winter 2001/2002 scheduling seasons. The decision taken to mitigate the impact of these events on the air carriers was to constrain coordinators to accept that air carriers were entitled to the same series of

slots during the summer scheduling season 2002 and the winter scheduling season 2002/2003 as the ones allocated to them on the date of 11 September 2001 for the summer scheduling season 2001 and the winter scheduling season 2001/2002 respectively, without considering the utilisation rate.

- Regulation 1554/2003: the war launched in March 2003 against Iraq and the political developments that followed, as well as the outbreak of the Severe Acute Respiratory Syndrome (SARS), seriously affected the operations of air carriers and triggered a significant reduction in demand in the beginning of the summer 2003 scheduling season. The decision taken to mitigate the impact of these events was to constrain coordinators to accept that air carriers were entitled to the same series of slots during the summer 2004 scheduling season as the ones allocated to them during the summer 2003 scheduling season without considering the utilisation rate.
- Regulation 545/2009: the global economic and financial crisis was seriously affecting the activities of air carriers and led to a significant reduction in air traffic over the winter 2008/2009 scheduling period and the summer 2009 scheduling period. The decision taken to mitigate the impact of these events on the air carriers' activities was to constrain coordinators to accept that air carriers were entitled to the same series of slots for the summer 2010 scheduling period as the ones allocated to them at the start of the summer 2009 scheduling period without considering the utilisation rate.

Although the European Regulation is broadly based on the IATA guidelines, the EC Slot Regulation contains some specific measures to promote non-discriminatory behaviour, support protection for routes serving Public Service Obligations (PSO) and encourage new entrants.

2.2.1 Definition of 'slot'

The first approach followed by the European Commission in Regulation 95/93 regarding the definition of slot, following the IATA guidelines at the time, was "the scheduled time of arrival or departure available or allocated to an aircraft movement on a specific date at an airport coordinated under the terms of this Regulation". This definition opened issues regarding the ownership of slots, as three separate parties laid claim to these property rights: the state, the airport operators and the airlines. These issues ended up with a modification of the slot definition in the amendment of Regulation 95/93 in 2004, Regulation 793/2004.

'Slot' is defined in the current EC Regulation as "the permission given by a coordinator in accordance with this Regulation to use the full range of airport infrastructure necessary to operate an air service at a coordinated airport on a specific date and time for the purpose of landing or take-off as allocated by a coordinator in accordance with this Regulation".

Such definition is fully in line with the one provided by IATA in [34]: "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".

It must be noted that, according to these two definitions, the runway does not constitute the only capacity-constrained resource: the definitions include the full range of airport infrastructure, i.e. runway, terminal, apron, gates, night quota, etc. Practically a slot is a temporal permit to perform operations: the slot time defines the moment of leaving or arriving at the aircraft stand (in-block, off-block) and is usually equal to the layover based on the published flight times.

2.2.2 Conditions for airport coordination

Both the EC Slot Regulation and the IATA Worldwide Slot Guidance (WSG) define different levels of airport coordination. According to the EC Slot regulation, the levels of airport coordination are:

- Coordinated airport: any airport where, in order to land or take off, it is necessary for an air carrier or any other aircraft operator to have been allocated a slot by a coordinator, with the exception of State flights, emergency landings and humanitarian flights;
- Schedules facilitated airport: an airport where there is potential for congestion at some periods of the day, week or year which is amenable to resolution by voluntary cooperation between air carriers and where a schedules facilitator has been appointed to facilitate the operations of air carriers operating services or intending to operate services at that airport.

In the IATA WSG, the different categories of airport coordination are identified with 3 levels, which are aligned with the two ones mentioned above, level 3 being coordinated airports and level 2 facilitated airports. IATA WSG also adds the category of non-coordinated airports (Level 1) for completeness.

According to the EC Slot Regulation, the Member States are responsible for designating airports as schedules facilitated or coordinated. The only conditions Member States have to meet in order to indicate one airport as schedules facilitated or coordinated is to guarantee the principles of transparency, neutrality and non-discrimination in the discussions conducted between the schedules facilitator and the aircraft operators.

The designation of an airport as coordinated or schedules facilitated shall be preceded by a capacity analysis and a consultation on the capacity situation with the airport managing body, the air carriers using the airport regularly, their representative organisations, representatives of general aviation using the airport regularly, and the air traffic control authorities. A thorough capacity analysis shall be carried out at any airport by the airport managing body or any other competent body in order to determine any shortfall in capacity, taking into account environmental constraints, when one of the following situations occur:

- the Member State considers it necessary;
- within 6 months following a request from air carriers representing more than 50% of the operations at the airport considering that the airport capacity is insufficient;
- within 6 months following a request from the airport managing body considering that the airport capacity is insufficient;
- within 6 months upon request from the Commission, especially where an airport is only accessible for air carriers that have been allocated slots or where air carriers (in particular new entrants) have serious problems in securing landing and take-off possibilities.

This analysis shall consider the possibility of overcoming such shortfall through new or modified infrastructure, operational changes or any other change.

An airport may also be designated as coordinated in exceptional circumstances where capacity problems occur for at least one scheduling period, such that significant delays cannot be avoided and it is impossible to resolve the shortfall in the short term.

2.2.3 Appointment of slot coordinator

According to the EC Slot regulation, a schedules facilitator or a coordinator must be a qualified natural or legal person, acting in an independent, neutral, non-discriminatory and transparent manner. Each country has an appointed responsible member with the airport coordination role. The Member State responsible for a schedules facilitated or coordinated airport shall ensure the independence of the coordinator at a coordinated airport by separating the coordinator functionally from any single interested party. The system of financing the coordinators' activities shall be such as to guarantee the coordinator's independent status.

Both coordinators and schedules facilitators shall participate in international scheduling conferences of air carries permitted by the Community law.

The Airport Slot Coordinator's role is three-fold:

- to prepare the allocation of airport slots to aircraft operators wanting to operate from/to a fully coordinated airport on a seasonal basis, in a neutral, non-discriminatory and transparent way;
- to facilitate the operations of aircraft operators at schedules facilitated airports. The corresponding responsibility (Airport Slot Negotiation) is to negotiate the allocation of airport slots with the aircraft operators in accordance with the rules and regulations and to define the airport slot allocation plan;
- to monitor the use of airport slots and adherence of Aircraft Operators to allocated schedules. The corresponding responsibility (Airport Slot Monitoring) is to monitor that the utilisation of airport slots by the aircraft operators is in accordance with the airport slot allocation plan.

The schedules facilitator shall advise air carriers and recommend alternative arrival and/or departure times when congestion is likely to occur.

In addition to its own tasks, the coordinator shall on request and within a reasonable time make available free of charge for review to interested parties, in particular to members or observers of the coordination committee, the following information:

- historical slots by airline, chronologically, for all air carriers at the airport;
- requested slots (initial submissions), by air carriers and chronologically, for all air carriers;
- all allocated slots, and outstanding slot requests, listed individually and in chronological order by air carriers, for all air carriers;
- remaining available slots;
- full details on the criteria being used in the allocation.

2.2.4 Determination of capacity and associated coordination parameters

Regulation 95/93 defines coordination parameters as the "expression in operational terms of all the capacity available for airport slot allocation at an airport during each coordination period, reflecting all technical, operational and environmental factors that affect the performance of the airport infrastructure and its different sub-systems".

Member States shall ensure that a thorough capacity analysis is carried out at an airport before declaring it as coordinated. The analysis, based on commonly recognised methods, shall determine any shortfall in

capacity, taking into account environmental constraints at the airport in question. The analysis shall consider the possibilities of overcoming such shortfall through new or modified infrastructure, operational changes, or any other change, and the time frame envisaged to resolve the problems.

The number of air transport movements (ATMs) at Level 3 airports is specified in detail according to the time of day; Regulation 95/93 assumes that all air services are operated under Instrument Flight Rules in IMC. When adverse weather conditions are experienced, this enables the flow rates to be maintained and delays to be minimised.

Declared capacity values may differentiate between arrival, departure and total movements. This results in a capacity declaration profile, which may vary throughout the airport opening hours to reflect the historical traffic mix and permit the possibility of recovery from demand peaks by incorporating a “fire-break” in the schedule.

Declared capacity is underpinned by assumptions on a seasonal weather norm, operational practices designed to maximise the productivity of the airport infrastructure and recognition of external constraints. Typically these might embrace:

- noise and emission constraints;
- ground handling and capacity of terminal facilities;
- runway capacities;
- taxiway capacities;
- stand allocation/planning;
- de-icing positions.

For example, taxiway usage rules are defined for all traffic and depend on the runway configurations in use and the weather conditions. Meanwhile, stand allocation usage rules are defined for each type of aircraft and priority criteria could be established depending on the airline or type of cargo.

The duration of blocks can vary and multiple constraints in terms of capacity per blocks of different duration can exist. Usually 60-mins blocks are used to determine the maximum number of slots, while blocks of 30 and 10 minutes are optionally used to control the concentration of flights [53].

A coordination committee at each coordinated airport is responsible for the timely provision of the coordination parameters to the coordinator. The committee includes amongst others air carriers, the managing body of the airport, the relevant air traffic control authorities as well as the regulatory authority.

2.2.5 Primary airport slot allocation according to grandfathering and use-it-or-lose-it rules

The primary allocation of slots is an administrative process: Member States designate congested airports as coordinated, and slot coordinators at each of these airports seek to balance the demand for slots with the supply.

Each coordinated airport must specify a declared capacity (in number of aircraft movements per unit of time) taking into account all the constraints affecting availability of resources.

Users interested in scheduling operations at these airports must send a formal request for each desired slot. The submission of planned schedules from airlines to the responsible coordinator must be done about five months in advance of the upcoming season. Slots are allocated in series, i.e. sequences of at least five slots at the same time on the same day of the week, distributed regularly in the same scheduling season, e.g., a series of 09:15 departure slots over at least five consecutive Mondays.

In Figure 1 below there is an example of a series of slots depicted together with examples of what is not considered a series of slots.

Figure 1. Example of Series of Slots and what is not considered a Series of Slots

Two fundamental criteria are applied when allocating the available capacity: historical precedence (the so-called grandfather rights) and time adjustments of historical slots.

Airlines can earn historic rights or grandfather rights to a series of slots, provided they operate the slots as allocated by the coordinator at least 80% of the time during a season (use-it-or-lose-it rule, also called 80-20 rule). Airlines can lose historic rights due to repeated and intentional slot misuse. Grandfather rights only apply to series of slots, never to single slots or other ways of grouping slots. Single slots and other groups of slots will return to the slot pool the following season.

The use-it-or-lose-it rule has some exception where an airline can justify a slot usage below 80% by one of the following reasons:

a) unforeseeable and unavoidable circumstances outside the airline's control leading to the grounding of the aircraft type, closure of the airport or serious disturbance of operations at the airports concerned;
b) interruption of air services due to an action intended to affect them and which makes it practically and/or technically impossible to operate;
c) serious financial damage for a community airline;
d) judicial proceedings concerning the imposition of public service obligations resulting in a temporary suspension of the operation of such routes.

As already explained at the beginning of section 2.2, in the case of certain extraordinary events, such as the terrorist acts of the 11th September, specific amendments to the regulation were made so as to cancel the use-it-or-lose-it rule for one or more seasons, in order to mitigate the impact of such events on air transport operations.

Time adjustments of historical slots are made after historical precedence has been taken into account and before the allocation of the remaining slots from the pool to the other applicant air carriers. Re-timing of series of slots is carried out only for operational reasons or for improvement of the slot timing of the applicant air carrier with respect to the timing initially requested. If a requested slot cannot be accommodated, the coordinator informs the requesting air carrier of the reasons and indicates the nearest alternative slot. If no adequate alternative is available or acceptable, the slot request is rejected.

In those situations where all slot requests cannot be accommodated to the satisfaction of the airlines concerned, commercial air services — in particular scheduled services and programmed non-scheduled air services — have preference over the others. In the case of competing requests within the same category of services, year-round operations are prioritised.

When there are public service obligations (PSO) imposed on a route, the State may reserve the slots required for the operations envisaged on that route, in accordance with Article 4 of Regulation (EEC) No 2408/92.

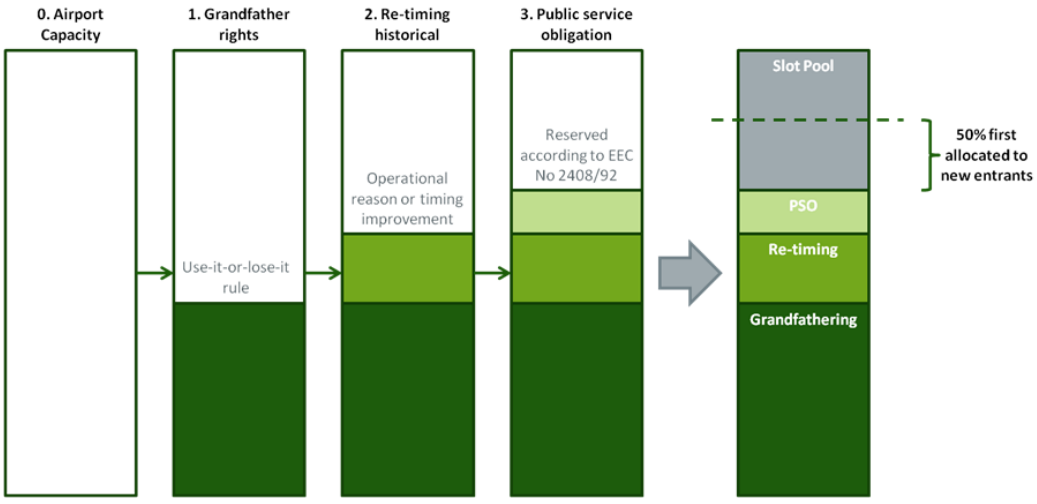


Figure 2. Slot allocation process

After this first assignment to incumbent airlines and the slot reservation for PSOs, a slot pool is created with the remaining slots. Fifty percent of this slot pool is allocated free of charge by the slot coordinator to new entrant airlines. An airline is considered a new entrant at an airport on a particular day if, upon allocation,

a) it would hold fewer than five slots in total on that day; or
b) for an intra-EU route with less than three competitors, it would hold fewer than five slots for that route on that day.

The remaining slots in the pool are allocated giving priority to year-round commercial air services.

Within each category (changes to historic slots, allocations to new entrants and other allocations from the slot pool), a request to extend an existing operation to operate on a year round basis should have priority over a new slot request.

Coordinators allocate the available capacity based on the following broad priority order:

a) a series of scheduled services;
b) ad hoc services;
c) other operations.

Other criteria to be applied when slots cannot be allocated based on the above mentioned rules are:

d) Effective Period of Operation: the schedule that will be effective for a longer period of operation in the same season should have priority;
e) Type of Service and Market: the balance of the different types of services (scheduled, charter and cargo) and markets (domestic, regional and long haul), and the development of the airport route network should be considered.
f) Competition: coordinators should try to ensure that due account is taken of competitive factors in the allocation of available slots;
g) Curfews: when a curfew at one airport creates a slot problem elsewhere, priority should be given to the airline whose schedule is constrained by the curfew;
h) Requirements of the Travelling Public and Other Users: coordinators should try to ensure that the needs of the travelling public and shippers are met as far as possible;
i) Frequency of Operation: higher frequency such as more flights per week should not in itself imply higher priority for airport slot allocation;
j) Local Guidelines: the coordinator must take local guidelines into account should they exist. Such guidelines should be approved by the Coordination Committee or its equivalent.

Slots are allocated in scheduling seasons — summer starting in late March and winter starting in late October. The initial allocation of slots occurs in advance of the biannual IATA Slot Conferences held each November (summer) and June (winter).

2.2.6 Slot Returns

Airlines shall return slots that are allocated to them but they do not intend to use. Returns shall take place before the slot return date to allow better opportunities for a successful reallocation by the coordinators and to provide available capacity for schedules adjustments as described above. The slot return date of each schedule season is dated about 2 months before its start: January 31st for summer scheduling season, and August 31st for winter season.

Late slot returns are considered as unused slots and thus will diminish an airline's opportunity to achieve historical status for certain slots or series of slots. This procedure features characteristics of a slight penalisation for late slot returns.

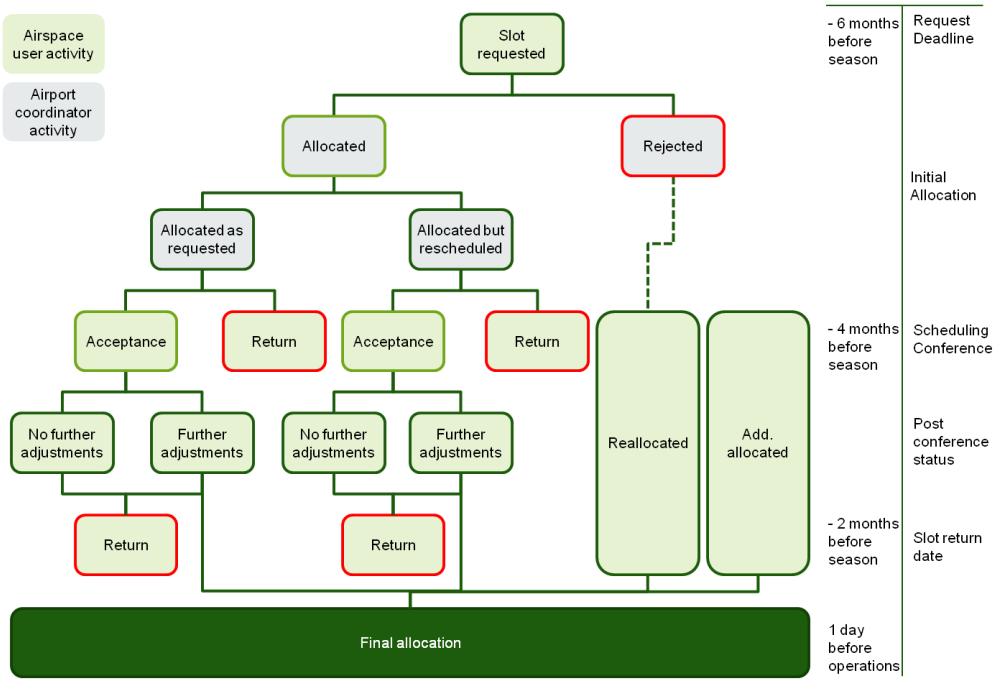


Figure 3. Theoretical slot return timings (Source: RTWH Aachen)

2.2.7 Slot exchanges and transfers

Description of the current IATA system

Under the IATA Guidelines, following primary allocation, slot exchange is expressly encouraged (provided that, in the case of newly allocated slots, the coordinator is satisfied that the exchange improves the operating position of the airline to which the slots were originally allocated). Slots may be freely exchanged on a one for one basis at a coordinated airport by any number of airlines; and indeed, to encourage and facilitate multilateral slot exchanges, the IATA website [33] is available for airlines to inform other airlines about their needs and any current slot holdings available for exchange.

Slot transfers (i.e. without an exchange) may only take place where the laws of the relevant country permit it, and only to airlines serving or planning to serve the same airport. However, transfers of new slots are not

permitted until such slots have been operated for two equivalent scheduling periods, in order to prevent airlines from taking advantage of an enhanced priority, such as new entrant status, simply by transferring them to another airline.

Shared operations are also allowed, so that slots held by one airline are used by another airline. Shared operations may only take place where not prohibited by the laws of the relevant country. The original slot holder retains historic precedence.

An airline that ceases operations at an airport must immediately return all the slots allocated to it for the remainder of the season and for the next season (if already allocated), and inform the coordinator whether it will use the slots in the future.

In the IATA Guidelines there is no bar to monetary consideration being involved in secondary trading. A system of secondary trading would therefore not appear to be inconsistent with the IATA system.

Description of the current EC system

Under the EC Slot Regulation, following primary allocation, slots may be exchanged or transferred between airlines in certain specified circumstances (and then subject to certain exceptions). Slots may be:

1. transferred by an air carrier from one route or type of service to another route or type of service operated by the same air carrier;
2. transferred:
    i) between parent and subsidiary companies, and between subsidiaries of the same company;
    ii) as part of the acquisition of control over the capital of an air carrier;
    iii) in the case of a total or partial take-over, when the slots are directly related to the air carrier taken over;
3. exchanged one for one, between air carriers.

Exchanges and transfers are always subject to the express confirmation of the coordinator. The coordinator must not confirm a transfer or exchange unless it is in conformity with the Regulation and it is satisfied that airport operations will not be prejudiced. The coordinator must also be satisfied that the slots are not the ones which are reserved for a PSO route and that slots allocated from the pool to those qualifying for them as “new entrants” may not be exchanged or transferred by them for a period of two equivalent scheduling periods.

Even if not explicitly specified by the Regulation, it is assumed that an exchange of slots “one for one” refers to slots at the same airport.

Regarding shared operations, the EC Slot Regulation provides that “slots allocated to one air carrier may be used by (an) other carrier(s) participating in a joint operation (...)” and “in the case of services operated by a group of air carriers, such carriers can use each other’s’ slots”. “Group of air carriers” is defined (Article 2 (f) (ii)) as “two or more air carriers which together perform joint operations, franchise operations or code-sharing for the purpose of operating a specific air service”. This allows, for example, carriers in the same

alliance to use each other's slots when performing joint operations or code sharing, although any actual exchange or transfer is still subject to Article 8a.

The current EC Regulation is silent on the monetary compensation accompanying slot exchanges and transfers. In Heathrow airport, there are cases of exchanges of slots in which an airline has exchanged a highly valuable slot against a so called "junk" slot, which is a slot with no commercial value; the air carrier receiving the highly valuable slot at peak time pays a monetary compensation to the "seller", and the "junk" slot usually ends up returning to the pool.

On 30 April 2008, the European Commission issued a clarification of the Slot Regulation. In his press release, Jacques Barrot, Vice-President of the European Commission, said:

"At crowded airports, we need to make sure that slots are used as efficiently as possible and that airlines have a fair chance to develop their operations. Slots at airports must be distributed in a fair and non-discriminatory way. Today we are recognising for the first time that secondary trading is an acceptable way of allowing slots to be swapped among airlines. We will keep a close eye on the situation across Europe and ensure that secondary trading works to the advantage of consumers, but this system has already shown its value in London, where it has allowed a range of airlines to take advantage of the opportunities provided by the EU-US aviation agreement and to create new levels of competition".

2.2.8 Slot trading

When Regulation 95/93 was drafted, the EC followed the principles of IATA WSG. Art. 8(4) of the Regulation 95/93 stated that "slots may be freely exchanged between air carriers or transferred by an air carrier from one route or type of service to another, by mutual agreement or as a result of a total or partial takeover or unilaterally". Though different EU officials reiterated that the Commission's position was that slot trading was in principle illegal, the text of the Regulation gave rise to much discussion as to whether it indeed prohibited any form of slot trading. In Regulation 793/2004, slot trading was in principle refused due to the risk that it would reinforce the dominant position of incumbent carriers at congested European airports, but the political discussion led to a Regulation that was still ambiguous: neither is secondary trading explicitly allowed nor is it explicitly forbidden. In practice, secondary slot trading has been in operation at UK airports for some time, as the EC recognised in 2008 [19].

Within the EU, slot trading is therefore not specifically regulated at the time being. The ground rules for slot trading have evolved from the general principles of airport slot allocation contained within the EU Slot Regulation and the IATA Worldwide Slot Guidelines. These ground rules are:

- willing buyers and willing sellers: airlines are free to choose whether to trade slots and with whom. There is no compulsion to sell slots or to accept the highest bid;
- only airlines can hold and trade slots: a slot holder must be an airline with a valid operating licence. Non-airline entities cannot hold slots, and if an airline loses its operating licence its slots are forfeited to the pool – they cannot be considered assets for liquidation;
- slots are subject to use-it-or-lose-it rules: airlines must operate slots as allocated by the coordinator at least 80% of the time during a season to earn or retain historic rights to the slots. Airlines can lose historic rights to slots for repeated and intentional slot misuse;

- slots are permissions to use a bundle of airport infrastructure: slots are not just a runway time, but include access to all scarce components of airport capacity (terminal, apron, gates, night quota, etc.). Typically slots are traded as a bundle, but it is possible to construct trades for individual components of capacity;
- slots are traded by way of a one-for-one slot exchange: to overcome this rule, the slot exchange often involves swapping historic peak time slots for newly allocated off peak slots. The off peak slots is then returned to the pool after the exchange, so that the net effect of the exchange is the transfer of peak time slots from Airline A to Airline B;
- the coordinator must confirm the feasibility of any slot trade: in confirming feasibility, the coordinator must ensure that airport operations would not be prejudiced (e.g., that there is sufficient terminal capacity available if the slots are operated with a larger aircraft). There are additional restrictions on trading new entrant slots and slots used on PSO routes. The coordinator shall undertake his role in an independent, transparent and non-discriminatory way;
- slots are traded in seasons: in order to complete a year-round slot trade, two separate transactions are required to exchange slots for the summer and winter seasons. Slots can be exchanged at any time after the initial allocation of slots in November for a summer season and June for a winter season;
- only slots in the future can be exchanged: slots can be exchanged for the next season (after the initial allocation of slots) and for the remainder of the current season. In the case of a mid-season exchange, slots for the beginning part of the season must be either (a) exchanged separately, or (b) requested by the new slot holder as “fill in” slots from the pool, in the next equivalent season;
- only slots with historic rights can be traded: in order to prevent abuse of the free primary allocation of slots by the coordinator, slots must be operated during at least one season and historic rights earned before they may be traded in the next equivalent season. Slots allocated on the basis of a new entrant priority cannot be traded until they have been operated for two equivalent seasons;
- slot trade transactions are transparent but price disclosure is not mandated: the coordinator has a duty of transparency, so the details of slots traded between airlines may be disclosed to interested parties. It is currently not mandatory for airlines to disclose other details of the trade, such as any monetary or other compensation accompanying a trade.

2.3 Coordination at European and worldwide level

Airport slots are not independent time permissions which can be easily modified, as a schedule change at one airport can affect one or more other airports. The structure and organisation at international level is a key element in the airport slot allocation process and for that purpose different associations intervene. In the following sub-sections, we describe the airport coordination associations and the activities related to airport slot allocation conducted by IATA.

2.3.1 Airport coordinators associations

European airports account for about 60% of all Level 3 slot coordinated airports in the world. Within the remaining 40% of coordinated airports located in other regions, about half of them are located in the Asia Pacific Region.

The European Airport Coordinators Association (EUACA) is the association of coordinated and schedules facilitated airports within Europe. There are a total of 25 European coordinators and schedules facilitators represented in EUACA. Its database contains information related to 25 different countries and 190 airports:

- 94 coordinated airports;
- 60 schedule facilitated airports;
- 36 other airports (not coordinated nor schedule facilitated) from which data is collected.

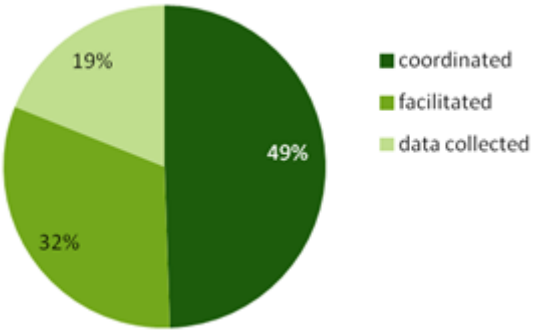


Figure 4. EUACA members

As it can be appreciated, almost half of the airports represented in EUACA are coordinated airports.

As an average, there are almost 4 coordinated airports in each European country, but their distribution within Europe is far from homogeneous. The States with more coordinated airports are Greece (22), Spain (16) and Italy (14). In the figure below, the location of the coordinated, facilitated and data collected airports is illustrated.

In Annex II one can see the list of the different responsible members represented by EUACA.

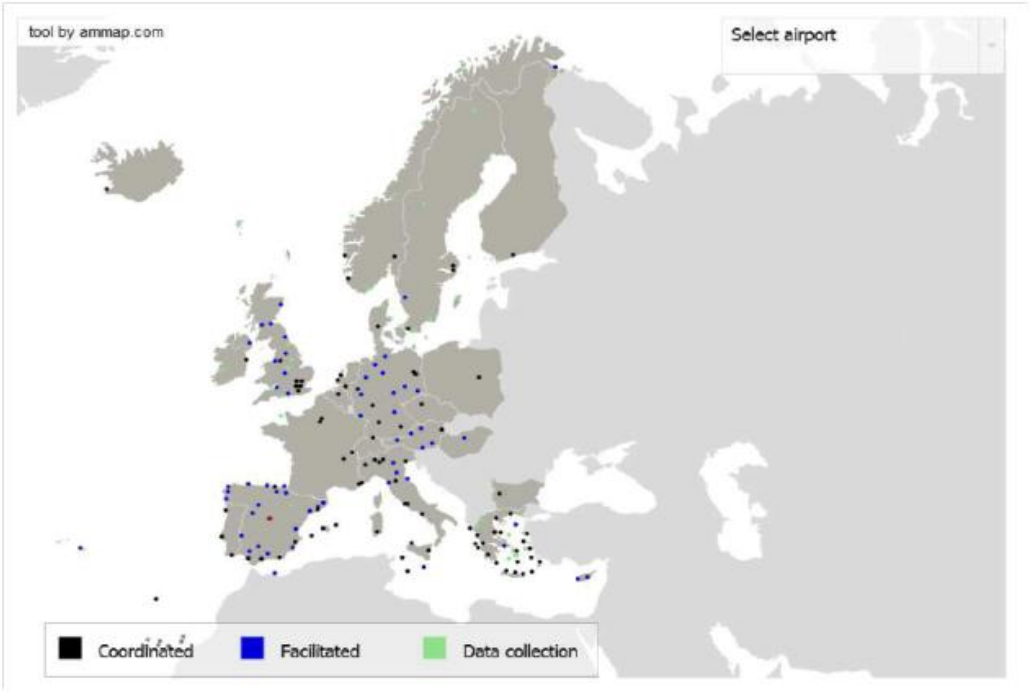


Figure 5. Geographic distribution of EUACA members

In the same way that the European coordinators are associated through EUACA, there is a similar association worldwide called Worldwide Airport Coordinators Group (WWACG). The WWACG represents a total of 87 coordinators, which concerns 313 airports and 69 different countries. The distribution of the type of airports is very similar to the one in Europe:

- 158 coordinated airports (51%);
- 118 facilitated airports (38%);
- 35 other airports from which data is collected (11%).

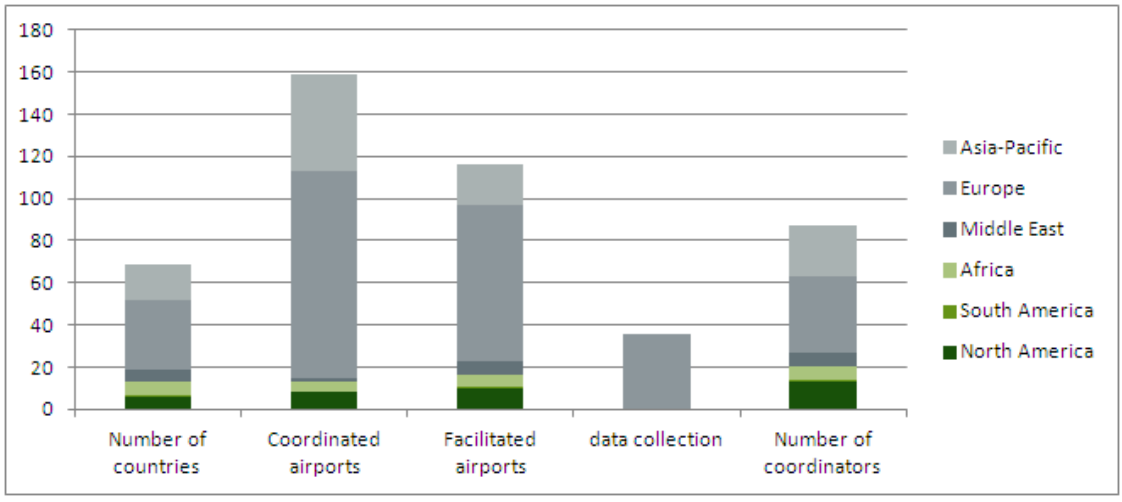


Figure 6. WWACG members distribution

2.3.2 The IATA airport slot allocation activities

The International Air Transport Association (IATA) is an international association representing some 240 airlines. Among its activities, IATA manages and publishes the Worldwide Slot Guidelines (WSG), which are intended to provide guidance on the allocation of airport slots and set the baseline for most of the airport slot allocation regulations worldwide.

The main instrument of the IATA slot allocation system is the organisation of biannual, international scheduling conferences with the participation of slot coordinators, airport representatives, and airline delegates. The IATA Slot Conferences (SC) are organised the Thursday after the second Saturday in November, for the summer scheduling season, and June, for the winter scheduling season.

The worldwide IATA Schedules Conference takes place after the initial allocation, involving airline representatives and airport coordinators into negotiation, arrangement of slot amendment, slot alternatives and slot exchange (between airlines). Schedule adjustments are carried out through bilateral discussions between airlines and coordinators. Schedules adjustments may continue until the day of operations, mainly following first-come-first-served criteria, i.e. by using waiting lists.

As a schedule change at one airport could affect one or more other airports, the conference provides the best forum in which all such interdependent changes can be quickly and efficiently processed and all airlines can leave the conference with schedules which they consider are the best compromise between what is wanted and what is available.

The IATA Slot Conference is convened solely for the purpose of allocating and managing slots. Discussions about pooling of flights, pricing, market entry or any other competitively sensitive activities beyond the scope of the SC are not permitted. For that reason, delegates at the SC must be the accredited representatives of their airlines or coordination organisation. IATA maintains a directory of companies participating in the SC and the individuals designated by their companies as Heads of Delegation. This directory lists the names and contact details of coordinators and facilitators, and those authorised to trade, exchange or make slot requests on behalf of a participant airline.

The baseline of the IATA SC is the entitlement of airlines to historic slots. For that reason, information must be provided by airport coordinators to airlines and vice versa regarding the slots with grandfather rights. At the biannual conferences, airlines seek to modify their schedules by exchanging or transferring between themselves their existing slot holdings and trying to obtain additional slots that occasionally become available.

The after conference activity involves bilateral negotiations among airlines with the aim to establish mutually beneficial exchanges of slots.

2.4 Current slot exchanges: experiences of secondary trading

2.4.1 Slot mobility

'Slot mobility' can be defined as the extent to which the airlines that held slots at the start of one period still held the slots by the end, [48]. SDG analysed slot mobility at some of the major European airports during the period 2007-2010. At the most congested airports, there was limited change in the allocation of slots during this period (e.g. 6.6% at Heathrow or 9.5% at Frankfurt), with the exceptions of Dusseldorf (27.6%) and Gatwick (39%).

2.4.2 Experiences of secondary trading

In the US air carriers are allowed to trade slots since the adoption of the so-called 'Buy-Sell Rule' in 1985, and there are well-known cases of carriers like US Airways or Delta engaging in major slot transactions. Secondary slot trading appears in some cases to have been a useful tool that has led to increased slot mobility. There are many slot swaps for timing adjustments, but relatively few permanent or long-term transfers, most of them taking place between large carriers. Most of the secondary trading activity has taken the form of leasing, as opposed to outright sales. It is worth noticing that not all the opinions concur. According to the US Government accounting office the trading just solidified the dominant carriers and they continued to lease slots as a way of babysitting them (see section 0). A detailed analysis of the US secondary market can be found e.g. in [39].

In Europe, an official market for slots does not exist. However, a grey market has developed at certain airports, with buying, selling and leasing of slots occurring through "fake" or "artificial" exchanges. Secondary trading primarily occurs at London Heathrow and, to a lesser extent, Gatwick. It is not transparent whether secondary trading occurs at other EU airports, but the slot coordinators have identified that "fake exchanges" have occurred at other airports like Frankfurt, Düsseldorf and Vienna [48]. Slot trades at Heathrow have periodically caught the attention of the public, though the transaction values that are reported in the media are only a small proportion of the total and most likely represent the high value end of the market. The coordinator, ACL, reports that it has facilitated about 200 Heathrow slot trades involving over 2,300 weekly slots since 2001. ACL has recently created a website showing details of slot trades: www.slottrade.aero. Some examples of Heathrow slot valuations from reported trades in the period 1998 to 2013 are shown in Table 2.

	Acquirer	Vendor	Number of daily slot pairs	Sum paid GBP million	Value per slot pair GBP million
1998	BA	Air UK	4	15.6	3.9
2002	BA	BA Connect	5	13	2.6
	BA	SN Brussels	7	27.5	3.9
2003	BA	SWISS	8	22.5	2.8
	BA	United	2	12	6.0
2004	Virgin	Flybe	4	20	5.0
	Virgin	Air Jamaica	1	5.1	5.1
2006	BA	BWIA	1	5	5.0
2007	BA	Malev	2	7	3.5
	BA	BMI	7.3	30	4.1
2008	Continental	GB Airways/Alitalia/Air France	4	104.5	26.1
2013	Delta	Not known	2	30.8	15.4
	Etihad	Jet	3	46.2	15.4
	Not known	Alitalia	3	67	22.3
	Qantas	Flybe	2	20	10.0

Table 2. Experiences of secondary trading (Source: [8])

2.5 Systems adopted in other regions

2.5.1 USA

Current situation

The term slot in the USA refers to the time window assigned to the aircraft for the use of the runway: "slot means the operational authority to conduct one IFR landing or take-off operation each day during a specific hour or 30 minute period at one of the High Density Traffic Airports" [15]. Differently from European situation, in the US only the use of runway is controlled; the capacity of no other airport facility is taken into account. Only four USA airports are currently slot-controlled: Ronald Reagan Washington National airport, and three New York area airports: JFK, Newark, and La Guardia. Slot regulation at these airports began in the late 1960s, as an attempt to reduce congestion and ensuing delays, and was termed the High Density Rule [16]. The regulation refers to slots as either "slots" (at Reagan National), or "operating authorization" (New York airports).

Grandfather rules

Before 1982 the airlines needed to use 65% of their assigned slots in order to keep them. In 1982 the rule was changed to 80%, in line with IATA slot guidelines. Although the 80 per cent usage requirement is applicable to all four slot-controlled airports, other provisions of the rules differ between the airports, including:

- the hours when airlines are required to have a slot to operate a flight;
- the time periods for which slots usage is measured and reported to FAA; and
- whether airlines can buy or sell slots (see table 1- p. 10 of [51]).

Reagan National and La Guardia's 80% usage is measured over all days over 2-month reporting periods, while JFK and Newark's usage is measured for each day of the week over a scheduling season.

The biggest difference with respect to the European situation is that the airlines at these four airports are not required to schedule flights for all the slots they receive, while in Europe, airlines tend to schedule the flights for all the slots, and return the slots they do not intend to use. US Government Accountability Office [51] analysed this aspect for 2011, and found that the airlines in aggregate schedule between 80% and 100% of their slots. This practice (not scheduling all slots) is widely used to provide operation flexibility for airlines in case of unpredictable events (weather, maintenance and similar). While the airlines that have less slots would welcome stricter rules on the use of slots (requiring scheduling all the slots), the airlines holding more slots are against it as it would "reduce their scheduling flexibility".

Slot usage monitoring

In the USA, FAA is in charge of "administering the slot rules, which primarily includes airport slot allocation, transfers, and monitoring and enforcing airlines' compliance with the 80% slot usage requirement." However, the GAO analysis showed that the FAA "does not calculate or know airlines' schedule rates." At the time of the mentioned report, FAA did not require airlines to submit the slot usage data in one format, and

the computer systems they used were not able to compile the different data formats. Therefore, FAA was not able to provide a reliable and accurate picture of the actual slot usage.

Trading and auctioning

Slots for Reagan National airport can be sold, traded or leased, as regulated by the FAA buy/sell rule from 1986 [15]. As the slots for the New York area airports are within the FAA temporary orders and therefore are not considered to be the permanent solution, these slots can be only traded or leased. In 2008, the FAA proposed congestion management rules for JFK, La Guardia, and Newark "that would have created a market by annually auctioning a limited number of slots in each of the first 5 years of the rule, which had a 10 year term". However, the FAA cancelled the rule before it became effective as it was highly controversial. The DOT and FAA started to draft the rule for the "Slot Management and Transparency for LaGuardia Airport, John F. Kennedy International Airport, and Newark Liberty International Airport" in 2010. The aim of this rulemaking is to replace the FAA temporary orders imposed on these airports, with the more permanent rules. The new rules would also limit the number of operations, but would also establish a "secondary market for U.S. and foreign air carriers to buy, sell, trade and lease slots" [28] among themselves at these airports. Even though the original date for the rulemaking taking effect was October of 2011, the rule making is still in the process of the review and refinement.

Brief history of slots assignment in USA

The slot control in the USA was introduced through the High Density Rule in 1969, with the aim to reduce the congestion and delays at a few airports and delay propagation through the network stemming from airport congestion. The airports subject to the rule were: LaGuardia, Newark, JFK, Washington National and Chicago O'Hare. Newark was soon exempted.

Over the years the slot control management changed as a result of other changes (i.e. airline de-regulation of 1978) or based on the assessment of the slot control process and its effects. The FAA, airlines, and the USA government (Congress) were periodically assessing the slot control management and even more importantly the effects of the process, mainly in terms of congestion and delays. The changes were imposed as a result of assessments.

In the first period, the slots were allocated by the committee composed of the airlines serving the 5 (4) airports under the High Density Rule. After the de-regulation in 1978, it became more and more difficult for the airline scheduling committees to agree on the airport slot allocation as a consequence of increased competition. The scheduling committees were replaces by the slot procedures in 1986. The new slot procedures covered the withdrawal of slots used less than 65% of time, the return of slots, slot reallocation and buy and sell rule. Buy and sell rule allowed airlines to buy, sell or lease their slots.

The review of the slot management in the 90s revealed that the High Density Rule became a barrier to competition at slot-control airports. One of the reasons was the impossibility for new airlines to enter the slot-controlled airports. The assessment of buy and sell rule showed that only during the first year of the enactment of the rule about 50% of slots were bought/sold. Soon after, the percentage of actually sold slots went down to 10%. In the process, the incumbent airlines solidified their positions at the slot controlled

airports by buying the slots. After this initial period, most of the transactions focused on short-term leases of slots, which effectively prevented new entries. The incumbent airlines held on to their slots through the short-term leasing, and had always the option not to renew the lease. New entrants thus did not have the security of being able to establish a long-term market at these airports, which in turn are very important for building efficient airline network.

In April 2000, the Congress required the phase-out of the High Density Rule at LaGuardia, JFK (by 2007), and O'Hare. O'Hare was exempted in 2001. The rules were relaxed at the New York area airports as well. However, after this, more and more flights got scheduled and the delays increased, especially in the summer of 2007. In the aftermath (2007, and 2008) temporary slot control rules were imposed on Newark, JFK and LaGuardia that are to be in effect until October 2013, or until the DOT and FAA do not issue the congestion management rule (previously mentioned "Slot Management and Transparency" rule). The slots awarded under the temporary rules cannot be bought or sold. Only the trade can be asked for, and needs to be approved by FAA.

As can be seen, the airport slot allocation process in the USA went through different changes, many of them based on the assessment of the effects of the current rules/processes. The assessments usually revolved around congestion analysis and the ensuing delays, and around the market share and market entry analysis.

Airport efficiency

The analysis of the traffic at the slot-controlled airports and the comparison with the similar airports that do not have slots imposed shows that at the slot-controlled airports [51]:

- airlines are inclined to use smaller aircraft: because of this, FAA proposed to mandate an average minimum aircraft size to avoid some of the inefficiencies. In general non-legacy airlines were in favour of this rule, while the legacy airlines were opposed as, according to them, it would have a negative impact on the service to small and medium size markets (the access to these markets needs to be provided, by the FAA rules);
- flights have, in some instances, higher daily frequencies to the same destination: the concern is that the high frequency is the consequence of trying to preserve slots, and not of a sound business model;
- overall load factors are lower: according to airports and some airline representatives, some airlines would continue to operate the flights with the lower load factors (that would be discontinued at other airports) in order to preserve their slots. There could be another explanation: the New York area airports are high revenue airports, and the lower load factor flights might still be economically viable with respect to other airports.

2.5.2 Australia

There are eight Level 3 and four Level 2 coordinated airports in Australia. The Sydney International Airport is the only airport that is regulated by the State, under the Sydney Airport Demand Management Act from 1997. The act establishes the Slot Management Scheme, and the Compliance Scheme (established in 2012 with the most recent amendment). The concept of a slot [3] in Australia, specifically for the Sidney Airport, is

the following: “A permission for a gate movement is known as a slot. A slot allocated under the Slot Management Scheme will permit a specified gate movement at a specified time on a specified day.”

Trading

In the case of Sydney, the slots allocated under the Slot Management Scheme are not transferable, and can be only swapped, according to the slot swapping provisions in the same Scheme. It is not very clear if the slots can be swapped, transferred or sold at the other slot-coordinated airports that are not subject to the local regulations.

Slot usage monitoring

The Sydney Airport has the Compliance Scheme for the monitoring of use and abuse of the slots. Under the Compliance Scheme, the Slot Coordinator can impose penalties for “unauthorized aircraft movements, i.e. when the operator knowingly or recklessly allows the aircraft to engage in no-slot or off-slot movements”. The collected penalties are to be used by the Slot Coordinator to improve the slot management process. In order to support the monitoring under the scheme, the Sydney Airport has a document listing the standardised reasons the airlines can use to explain and justify their off-slot movements: “Sydney Airport Slot Management: Standardised Reasons” [49].

We assume that at the non-regulated slot-coordinated airports, the slot coordinator applies the slot usage monitoring as defined in IATA Worldwide Slot Guidance document.

Transparency

The Australian Slot Coordinator, Airport Coordination Australia, applies the standard IATA messages for the reception and allocation of slots. All the airport slot allocations are available on the coordinator’s website.

3. Performance of the current system and perspectives for reform

3.1 Perspectives for the reform of the slot system. Market-based approaches

Although there are other relevant questions related with slots, such as the determination of the optimal number of slots at a given airport, the problem of airport slot allocation is by far the most discussed in the literature. There are reasons for believing that the current airport slot allocation can be improved. Different directions for reform have been in the research and policy agenda for a long time. In particular, different market-based approaches have been proposed with the purpose of achieving a more efficient allocation. Market-based mechanisms are expected to bring appropriate incentives that will positively influence the behaviour of players in the market (airlines) so that the available scarce capacity is used by those airlines able to make best economic use of it.

3.1.1 Market-based mechanisms for primary allocation of capacity

The approaches currently implemented for the primary allocation of capacity at congested airports are the IATA administrative slot allocation regime (and its different instantiations, such as the EU regulation), and the free-schedule (i.e. regulated by congestion itself) system used in most US airports. The mechanisms proposed in the literature to improve the existing system include two main threads: auctions and congestion pricing.

Auctions

Economic theory indicates that the willingness-to-pay by a user reflects the welfare enjoyed by that user, which in turn is a reflection of the social welfare. Auctions are thus regarded as a more effective way of achieving an efficient airport slot allocation than other alternatives. Additionally, allocation of slots by auctions could be considered more equitable than allocation through historic preference, since the latter gives a major (and arguably unfair) advantage to airlines that obtained slots in the past, often when the airport was less busy and slots had little value.

However, auctions raise a series of practical problems [48], notably:

- the complexity of auctioning a large number of heterogeneous assets as slots are;
- auctions at different airports would be interdependent, with coordinated airports outside Europe using a different system. Airlines might be reluctant to bid for slots at an EU airport if they were unsure whether they would obtain slots through the normal allocation process at the other airport;
- it is possible that a carrier might not be able to finance slot purchase even where it was the most economically efficient purchaser of the slots;
- depending on who received the revenue from auctions, there could be a perverse incentive not to expand airport capacity.

Three main options for slot auctions have been considered:

- withdrawal of grandfather rights and auctioning of these slots;
- auctions of pool slots when new capacity is created;
- auctions for all pool slots.

Most analyses assume that the auction system would need to work in conjunction with secondary trading to allow adjustments.

Congestion pricing

Currently, airport charges are mainly based on aircraft weight. The idea of congestion pricing is surcharging airspace users for the use of scarce capacity to regulate demand, by establishing different prices along the day (e.g. peak / off-peak charges).

The main barrier for the implementation of congestion pricing is the need for an external estimation of demand elasticity and marginal congestion costs, and this is probably the main reason why, despite being conceptually well developed in the economics literature, congestion pricing has found limited practical application.

Unlike auctions, which automatically reveal information about relevant parameters as well as acting as allocation mechanisms, congestion charges need to be set by an external body that needs to calculate their appropriate level [6]. The difficulty to dynamically set the optimal structure and level of airport charges would most likely lead to efficiency losses [37].

Additionally, the practical experience indicates that institutional barriers may prevent peak pricing from being used effectively. The inherent problem is that transportation policy is determined primarily by government and not by the free market. Peak pricing is a theory that attempts to insert an element of the free market into a government-regulated market.

In Europe the British Airport Authority introduced peak pricing in the UK Airports it managed since 1972. The peak element of the pricing strategy initially charged £20 (the equivalent of around $50 at that time) per operation between the hours of 8:00 and 11:59 a.m. and only applied from May through October, while in May and June it was only in effect on weekdays. Changes to this initial pricing structure were made every year since its implementation, [44]. However US carriers complained about these charges since the beginning and a ‘‘British Airport Users’ Action Group’’ was formed by 18 airlines (larger aircraft operators who felt discriminated and refused to pay the fee) to sue the BAA. The suit was eventually settled out of court with a memorandum of understanding and the peak charge was eliminated in 1980, replaced by fixed element in weight charge. In the US, Boston Logan Airport has proposed at least five pricing scheme since the 1980's and implemented two of them [44] intended to reduce congestion. In this case it was the smaller aircraft users (commuter carriers and General Aviation) who challenged the rule in court on the base of being unfair and discriminatory and the fee structure was ultimately rescinded.

Congestion pricing is normally proposed as an alternative to slot constraints, but there is also some theoretical work which combines slot constraints and congestion pricing. Theoretically, under conditions of certainty, both congestion pricing and slot auctioning can generate optimal results from the point of view of

social welfare. However, under demand uncertainty, the welfare performance of each instrument can differ according to the structure of demand and congestion costs [13]. To address demand uncertainty, Czerny [13] proposes a solution based on the combination of lower/upper limits for congestion charges and slot constraints, consisting of:

- a sealed-bid, one price auction;
- a system in which slots are numbered and each slot has an associated congestion charge (to be paid only if the slot is used) equal to the marginal external congestion costs of operations given that all slots with a number smaller than or equal to the number of the respective slot are used; and
- a secondary market, in order to ensure that only the cheapest slots are used.

3.1.2 Secondary slot trading

Secondary trading refers to the redistribution of slots among airlines through a market where slots can be bought and sold. As a secondary mechanism, it operates after an initial (or "primary") allocation has been established. It is therefore compatible with the current administrative system for primary allocation, as well as with other possible mechanisms for primary allocation, such as auctions.

Secondary trading is envisaged as the result of bilateral negotiations between airspace users (buyers and sellers). The advocates of secondary slot trading argue that a secondary market would lead to an efficient airport slot allocation by dynamically reallocating slots to their highest valued uses, and should therefore achieve most of the potential benefits of withdrawal of grandfather rights and auctions while having much lower implementation costs and being fully compatible with the current primary airport slot allocation and scheduling procedures. A secondary market for airport slots has existed in a number of airports in the US since 1986; although the academic response to congestion has predominantly supported market-based mechanisms, the secondary trading approach employed in the US (together with the experiences in some UK airports) is the only existing scheme relying on market forces. Evidence from these markets suggests that there is a strong case for a secondary slot market. The Steer Davies Gleave Study commissioned by the EC in 2011 [48] recommends the introduction of secondary trading as an option permitted at all EU airports before withdrawal of grandfather rights is further considered.

On the other hand, some studies [40] argue that secondary trading might be less successful than auctions in promoting a more efficient use of slots. Though in principle there should be no difference in outcome between primary auctions and secondary trading, as both should lead to an economically efficient outcome as carriers should consider the opportunity cost of holding slots as being equivalent to the costs of acquiring them, this principle relies on the assumption that airlines are rational economic agents. Because airlines are confronted only with an opportunity cost, rather than a cash outflow, the response in some cases might be delayed, or might not occur at all; it may also happen that certain airlines are under pressure from governments to serve uneconomic routes; and there is the risk that certain deals do not take place either due to a failure in identifying buyers and sellers or because airlines are reluctant to sell slots to their competitors. According to NERA [40], the identification of buyers and sellers could be facilitated by introducing the figure of independent agents acting as facilitators, while the reluctance to sell slots to competitors is less likely to occur in practice. Finally, the emergence of a secondary market without formal

regulation raises other concerns, such as the concentration of slots among relatively few airlines or the elimination of particular routes.

If auctions are implemented as a primary mechanism, there is a general consensus on the fact that secondary trading should be allowed, in order to prevent the risk of airlines ending up with slots they could not use. In the case of auctions being applied only to pool slots, secondary trading should also improve the allocation of existing slots.

Steer Davies Gleave [48] concludes that the introduction of slot trading in Europe would have, among others, the following effects:

- At airports which already have significant volumes of secondary trading (Heathrow and Gatwick), explicit authorisation could increase the volume of trades, since some carriers might be more willing to participate in buying and leasing of slots, as the system would be more transparent and there would be greater legal certainty about the transaction.
- The main benefit of explicit authorisation of secondary trading would be at other congested airports at which secondary trading does not take place and relatively small aircraft are currently operated, often by the main based hub carrier. At Heathrow secondary trading has directly led to increased aircraft sizes, and hence more efficient capacity utilisation. The impact at airports not as congested as Heathrow could be much lower (as was the experience in Gatwick).
- Trading would appear likely to have the strongest impact at Paris Orly, where demand significantly exceeds capacity, slot mobility is currently very low, and there are no plans to expand capacity. Trading could also have a significant impact on slot mobility at Düsseldorf, even if it would be much less than at Heathrow or Orly (slot mobility is still quite high even without secondary trading).

3.2 The way forward proposed by the EC

Following a number of analysis and consultations carried out in the years 2010 and 2011 on how the current slot regulation is working, the European Commission concluded that the use of the scarce capacity at congested airports is not optimal. As a result, the Commission has proposed a number of changes to the current regulation. As part of the Airport package adopted on 1st December 2011, the EC launched a proposal aimed at favouring a more efficient use of scarce capacity at busy airports [21]. The new proposal:

- reforms the rules designed to help new entrants access the market at congested airports: in Article 2(b) the definition of new entrant is expanded, by removing the carve-out for airlines holding more than 4% of the total slots on a given day and increasing the threshold of total slots held within an airline's group from 5 to 10%. As previously, 50% of any spare slots will be made available to airlines falling within this definition;
- lengthens the minimum period of a slot series: in article 2(k) the definition of a series of slots has been increased from 5 slots to 10 in the winter and 15 in the summer. Such slots must also be held in consecutive weeks under the proposals, rather than at regular intervals as is currently the case. The main effect of this change is that historical precedence will not apply to series of slots shorter in length than 10/15 weeks;

- increases the level of transparency on slots transactions: in Article 4 airport coordinators are obliged to submit bi-annual activity reports, detailing airport slot allocation information and the results of a stakeholder survey. They must also maintain a freely-accessible electronic database of slot requests, allocations and current availability;
- formalises secondary trading in all member States, allowing airlines to trade slots with each other at airports anywhere in the EU in a transparent way. In Article 8a the restrictions on the transfer of slots are lifted (with the exception of those allocated to new entrants) so that airlines can freely trade slots amongst each other. The ability to exchange slots on a one-for-one basis is retained. A new provision has been inserted, obliging airlines to inform the coordinator of any monetary or other compensation associated with slot trades. It is unclear whether this information will be published, but the wider aim of increasing transparency suggests that this will be the case;
- tightens the rules to demonstrate that airlines have used their slots sufficiently during the season, increasing the minimum utilisation for a slot series. In Article 10(2) the use-it or lose-it rule is amended so that airlines must utilise at least 85% of a particular series of slots in order to inherit historical precedence or "grandfather rights" in the next equivalent season;
- forces the early hand-back of unutilised slots: in Article 14 the provisions relating to enforcement of sanctions are toughened, obliging Member States to ensure that sanctions are applied, rather than simply being made available. Sanctions are extended to cover late handback of unused slots, including a new provision permitting airports to charge a reservation fee for slots requested in the initial allocation process;
- advocates the integration of airport slot allocation with the Single European Sky initiative, by associating the European Network Manager with the airport slot allocation process;
- defines stricter criteria for the independence of the coordinators with respect to interested parties;
- asks for enhanced cooperation between the coordinators (e.g., for the development of common airport slot allocation software);
- opens the door to the future creation of a European coordinator responsible for airport slot allocation at all EU airports.

Therefore, the new proposal opened the door to the introduction of market-based mechanisms across the EU, in an attempt to ensure that slots are allocated to those carriers able to make the best use of them. In 2012, secondary trading of slots was endorsed by the European Parliament, which however rejected a rise in the use-it-or-lose-it obligation and the proposal to lengthen series in which slots are allocated.

Recent studies investigated the opportunity of implementing both primary slot auctioning and secondary slot trading, delivering promising results (see e.g. [9], [50]). However, market-based mechanisms can also have undesirable effects, such as the exercise of market power or the potentially negative impact on airline operating costs. A comprehensive assessment of such mechanisms should help develop a better understanding of the economic value of each slot, evaluate the effect of different possible market designs on network performance, and analyse the potential impact on competition and competitiveness of operators, among other aspects.

3.3 Towards a comprehensive performance framework for the assessment of airport slot allocation mechanisms

3.3.1 Concepts and definitions

A performance framework can be defined as the set of performance areas and indicators that will guide the evaluation of a particular airport slot allocation mechanism.

A performance area can be defined as a broad focus area encompassing one or several goals or objectives.

Indicators can be defined as a means of summarising the current position and the direction and rate of change of progress towards a particular goal. The use of indicators for the control and monitoring of processes helps evaluating and monitoring developments; focuses the discussion with stakeholders; promotes the idea of integrated action; demonstrates progress towards goals and objectives; and ultimately supports decision making. Indicators can be classified according to many different criteria. The criteria that we will use for the categorisation of indicators are described hereafter.

Outcome Indicators vs. Intermediate Indicators

Outcome indicators measure progress towards policy objectives (i.e. the variables one wants to optimise in the system).

Intermediate (or process) indicators, which provide useful information about the system (e.g. they may serve as a proxy for outcome indicators or have an influence on their evolution), but are not an objective per se. Expressing policy objectives in terms of intermediate indicators often leads to well-intentioned but ill-targeted policies.

Quantitative Indicators vs. Qualitative Indicators

Quantitative indicators use numbers and express amounts or quantities.

Qualitative indicators use words, symbols or colours to express attitudes and views.

Local Indicators vs. Global Indicators

Local indicators are measured at airport level.

Global indicators are measured at network level.

System-wide Indicators vs. Stakeholder Indicators

System-wide (or social) indicators are measured at societal level.

Stakeholder-specific indicators are linked to a specific stakeholder or group of stakeholders.

3.3.2 Required Properties

There is abundant literature on the requirements to be met by a performance framework to properly meet its intended functions. In the particular case of airport slot allocation, a performance framework should have the following properties:

- the framework should be comprehensive, i.e. encompass the full range of economic, social and environmental impacts of the airport slot allocation system;
- it should be target relevant, i.e. outcome indicators should be relevant to the target they intend to measure;
- it should be understandable to all stakeholders;
- outcome indicators should be independent of each other;
- indicators should be measurable based on available and reliable data.

3.3.3 Preliminary proposal for a comprehensive performance framework

A comprehensive evaluation of capacity allocation mechanisms requires an analysis of impact along several performance areas. The same performance area being often referred by several different names in the literature, hereafter we aim at establishing a common understanding of a set of relevant concepts. We have tried to be as consistent as possible with the concepts and terminology used by the SES II Performance Scheme and the SESAR Performance Framework (see Annex III for more details). Nevertheless we also include other dimensions which fall outside the scope of SES II and SESAR performance schemes, but are considered necessary for a sound and comprehensive impact assessment. Taking account these guiding principles, we propose a first categorisation of the impacts of capacity allocation mechanisms according to the following performance areas:

- Economic efficiency;
- Equity and Distributional Issues;
- Access and Competition;
- Flexibility, Resilience and Adaptability;
- Interoperability;
- Capacity and Delay.

Economic Efficiency

Economic efficiency measures the ratio between the total social welfare created and the maximum welfare that could be created. Social welfare is the sum of consumer and producer surplus (i.e. the sum of the effects on airlines, airports and passengers) and net benefits to third parties (externalities). The property of maximising economic efficiency is often referred to as social optimality [1]. According to economic theory, maximum efficiency is achieved only if a good is produced by the lowest cost producers and the products are consumed by the consumers with the highest willingness-to-pay.

When regarding airport capacity as a limited resource, economic efficiency is arguably the most adequate measure to evaluate its efficient use. Slots would be efficiently allocated when used by those airlines able to

generate the greatest social value. It seems therefore appropriate to define one outcome indicator accounting for economic efficiency, but the determination of the social value of a slot and thus the evaluation of economic efficiency is not an easy task. Economic efficiency includes all allocative and productive efficiencies, and finding the optimal trade-off raises a number of theoretical and practical difficulties. One of the main criticisms of the current airport slot allocation system is that it does not allocate capacity in an efficient manner: since it makes no explicit consideration of the value that airlines attach to a slot, services may not be allocated to those with the greatest willingness to pay and therefore slots may be operated inefficiently by airlines who do not make the most efficient use of the available capacity. It is generally accepted that market mechanisms, such as auctioning of slots or secondary trading, would improve allocative efficiency by bringing appropriate incentives so that the available scarce capacity is used by those airlines able to make best economic use of it [7], [29], [39], [40]. Congestion pricing could in principle lead to an equally efficient allocation, though the need to estimate demand elasticity and marginal congestion costs in order to dynamically determine the optimal structure and level of airport charges could lead to efficiency losses in practice. A detailed discussion of this issue can be found in [37]. On the other hand, these mechanisms could have an impact on productive efficiency that should not be underestimated. In what follows we make some considerations about several key dimensions that should be taken into account for a sound evaluation of economic efficiency, as well possible intermediate indicators associated to these dimensions which, while not appropriate to express policy objectives, can provide useful information about the system and help assess economic efficiency.

Revenues: to assess the extent of welfare creation, one should first assess consumer and producer surplus. By buying airline tickets, passengers would indicate their willingness to pay for the utility derived from a particular service [5]. Most literature on air transport economics argues that, given the sophisticated price discrimination strategies used by most airlines today, it is reasonable to take the value that an airline places on a slot as a proxy for consumer and producer surplus. However, due to the network nature of the air transport system, the calculation of revenues collected from passengers can become very complex, e.g. a small aircraft feeder flight could use slots more efficiently than a charter flight with more passengers, but less total revenue once network effects are taken into account [40].

Cost efficiency: Cost efficiency is used in SESAR to evaluate the cost of air navigation services for a flight. The ICAO equivalent KPA, Cost effectiveness, is defined as the full cost of providing the ANS, including appropriate amounts for cost of capital and depreciation of assets, as well as the cost of maintenance, operation, management and administration. In the case of capacity allocation, different capacity allocation mechanisms may affect cost efficiency in different manners:

- **Cost of operating the system**: one of the arguments in favour of the current system is that it is relatively simple and inexpensive [52]. This is also one of the arguments against the use of auctions for primary airport slot allocation: even if economic theory indicates that auctions should be a more effective way of achieving allocative efficiency than other alternatives, there is considerable concern about the cost of designing and operating an auction system, due to the complexity created by the interdependencies between the value of different slots. For an auction system to allocate access rights efficiently, the simultaneous auctioning of slots at all slot-constrained airports would be required, and airlines should be able to submit package bids, which leads to an extremely complex auction and

therefore to the need for sophisticated software and bidding facilities, which would impose high costs on both the auctioneer and the bidders. Even if auctions were used to allocate slots, a secondary slot market would still be necessary to ensure that airport slot allocation remains efficient by dynamically reallocating slots to their highest valued uses. Secondary trading should be significantly easier and cheaper to operate than auctions, so many authors argue that the most effective measure for the efficient allocation of scarce capacity would be the extended use of secondary slot markets [39]. These authors argue that, as long as slots could be traded in a secondary market and in the absence of market imperfections, the initial allocation of slots should make no difference in terms of efficiency [7]. The initial allocation will nevertheless affect wealth distribution; equity and distributional issues are discussed later on in this document, as a separate performance area.

- **Dynamic efficiency**: dynamic efficiency is concerned with the productive efficiency of a firm over a period of time. There may be a trade-off between static and dynamic efficiencies over different periods of time, and it is thus reasonable to argue that sacrificing efficiency in the short run is justified, for example, to reduce the cost of managing uncertainty in the long run. The argument of schedule continuity could be seen as a particular instance of this type of trade-off: incumbent carriers argue that grandfather rights maintain stability and continuity in scheduling, thus facilitating long term planning, operational stability and economic viability to airlines and airports; on the other hand, new entrants claim that grandfather rights deny them opportunities to enter the market, often leading to an inefficient use of capacity.
- **Cost of delay**: another issue identified in the literature on airport slots is that different airport slot allocation mechanisms may change not only the use of capacity at congested airports, but also lead to different route structures. Both factors may in turn affect delay distribution. The airport slot allocation system in comparison with the congestion system reduces the air carriers' costs of delay, as tactical delays are reduced in favour of scheduled delays. We address delays more in detail within the section dedicated to Capacity and Delays, but we will point out here that a lot of modelling work remains to be done for a proper quantification of the cost of delay for airlines and passengers [1], [10].

Externalities: as previously mentioned, in the presence of externalities, the value of a slot for an airline will not be the same as the social value of a slot. Examples of externalities are the impact on environment or on the accessibility of European regions, which have been discussed e.g. in [40].

Allocative efficiency: it measures the capability of the strategy to allocate slots to those with the greatest willingness to pay [11], [50]. This performance aspect constitutes probably the major criticism to the current system. No considerations of the value that the airlines attach to a slot is done at the time of assigning slots implying that services may be operated inefficiently by airlines who do not make the most efficient use out of a slot. For example, at some airports at which demand exceeds capacity throughout the day, and where secondary trading does not occur (particularly Düsseldorf and to a lesser extent Paris Orly), a substantial proportion of slots are used for flights with quite small aircraft for airlines babysitting them. As a result of that, a company that is willing to fully operate these slots and values them most cannot gain access to them because the current operating airlines preserves the grand-father rights over those slots. This performance aspect is really difficult to be measured in the current system, since air carriers are not paying any fee for the allocation of slots; only in some special cases, where monetary compensations are provided together with

the slot exchanged can give an idea of the value that air carrier is giving to that particular slot, but as these cases are minimum and only conducted in certain airports (i.e. Heathrow airport) a general measurement cannot be obtained. Some studies consider the number of passengers carried as an indicator of allocative efficiency, but as indicated above, there may be the case were a small aircraft can provide greater economic value than a bigger one once its network impacts are taken into consideration.

Equity and Distributional Issues

The performance framework should not only address the total social welfare, but also the distributional impacts of different mechanisms, as they will alter how different stakeholders gain or lose. It is therefore important to define stakeholder-specific indicators which account for **revenues and costs per stakeholder**, so that they can then be used to assess the fairness of a certain mechanism. For example, due to commercial and operational reasons, an airline will have an ideal pair of departure and arrival slots (ideal slots) for each of its flights. When this ideal pair is not available, the airline has to advance or delay its flight, which induces an undesired cost (shift cost) [9]. From the airline's point of view, the main objective is the minimisation of its shift costs. A system-wide indicator instead may look for optimising the social welfare that, in this case, could be approximated by the minimisation of the sum of the shift costs imposed to all flights. However, this minimum overall cost could be achieved at the expense of some individual airlines or flights that can be enormously more penalised than others. The property of a mechanism such that each stakeholder is expected to get a non-negative utility is often referred to in the literature as **individual rationality** [1], [9].

While secondary trading should in theory improve equity, as both the seller and the buyer will only carry out a transaction if it increases their utility, this is not the case for other potential reforms, such as auctions or congestion pricing. The opposition from certain stakeholders to these mechanisms can be understood from this perspective. Incumbent airlines, for example, oppose slot auctions because they would reduce the slot rents they are currently obtaining thanks to grandfather rights. Airlines also oppose congestion pricing, as it would lower their profits. Generally speaking, mechanisms that could in principle have the potential of increasing social welfare may raise distributional issues if they don't include appropriate compensation mechanisms or certain constraints. An example is the question of who receives the revenues in the case of slot auctioning; it has been suggested, for example, that they could be earmarked for airport expansion. Reference [42] introduces some monetary compensation mechanisms in the airport slot allocation process for redistributing among airlines the surplus deriving from the elimination of grandfather rights.

Access and Competition

According to ICAO, a global Air Navigation System should provide an operating environment that ensures that all airspace users have the right of access to the resources needed to meet their specific operational requirements, while ensuring that the shared use of the airspace for different airspace users can be achieved safely. Generally, the global Air Navigation System should ensure an equitable treatment for all airspace users that have access to a given airspace or service, except where special considerations (e.g. significant overall safety or efficiency considerations, national defence, etc.) advise to establish priority on a different basis.

The issue of competition and access of new entrants is, together with that of economic efficiency (to which it is intimately and intricately linked), the other major criticism of the current system. In order to effectively compete with the dominant carrier at a given airport, a new entrant needs to build up a sustainable slot portfolio. Under the current rules, airlines quickly fall outside the definition of new entrant, which obstructs the growth of efficient competition [48]. At the same time, there is little incentive for incumbents to release slots even if they cannot use them efficiently ('slot hoarding' or 'babysitting'). Moreover, the slot pool is usually made of slots at less commercially attractive times than those assigned due to grandfathering. This aspect is also sometimes referred as 'competitive efficiency', i.e. the capability of promoting competition through the elimination of entry barriers to newcomers and discriminatory practices in favour of established carriers. It must also be pointed out that, even if the new entrant rule has not been overall extremely successful at promoting sustainable competition, it has made it possible for low cost airlines such as Ryanair and especially EasyJet to achieve significant growth at some congested airports. Schemes to provide equal opportunities to new entrants have been addressed in two recent studies. Reference [42] compares airlines' costs when grandfather rights are either enforced or not. Reference [38] introduces five types of airport slot allocation strategies consisting of different combinations of grandfather rights, central coordination and free market and characterised by an increasing level of differentiation with respect to the current system.

Among the competition indicators proposed in the literature, one can find the ratio between the number of slots allocated to new entrants and the total number of allocated slots, or the level of slot concentration. The use of this type of indicators has sometimes led regulators to take measures to limit such concentration. However, measuring slot concentration as an indicator of competition could be misleading. It may happen that the maximisation of social welfare occurs for a high level of concentration of slots at certain airports and there is some evidence that concentration of slots may increase when slot trading is allowed, which could be due to the value of slots in a hub and spoke network, so that large carriers could have a higher willingness-to-pay [30]. Reference [47] argues that higher fares at slot constrained airports do not necessarily constitute a case for abuse of market power; other reasons may exist, such as the cost of providing for passenger connections and operating at a bigger airport. The definition of suitable outcome indicators to measure competition is not a trivial task: there is a need for more sophisticated indicators able to grasp whether the output is being deliberately restrained below capacity, i.e. whether the airport slot allocation system prevents the entry of new competitors with a higher willingness-to-pay than those airlines operating the available slots.

Other aspects related to access and competition, which should be taken into consideration, are discussed below.

Access costs: one could think that if a primary airport slot allocation based on auctions were established, it would be more difficult for small carriers with lower purchasing power to get slots at the busiest airports. That airport slot allocation in the current system is free of charge is sometimes seen as a positive feature from the point of view of competition, though it would not necessarily imply more economic efficiency.

Public Service Obligations: PSO is an arrangement to operate a specified service of public transport for a specified period of time for a given subsidy. According to Article 9 of Regulation EC 95/93 as amended

in 2004, slots may be reserved for PSO routes. This guarantees that services to regional communities are operated regularly even in those cases in which they are not profitable for airlines.

Independence of the coordinator: according to the Regulation the coordinator must be a qualified natural or legal person, acting in an independent, neutral, non-discriminatory and transparent manner. But the limits of this independence are sometimes vague and may not be clear at first sight. As an example, in Spain the coordination is undertaken and fully funded by AENA, the national airport operator and air navigation services provider.

Transparency of slot information: the transparency and adequacy of slot information provided by coordinators to the different stakeholders could be improved. According to [48], several airlines believe that they should receive more information on actual coordination parameters, local rules and sanctions systems, and most stakeholders believe that standardisation of online formats across coordinators would be beneficial. Some airlines complain that when slots become available, not all coordinators make this publicly known, which may reduce the competition for these slots. The level of transparency may be characterised by means of a qualitative indicator, as a desirable feature from the point of view of institutional quality. Additionally, the question of what information is shared (and when) is a key design parameter for market mechanisms that will have an impact on the way the market develops.

Flexibility, Resilience and Adaptability

Flexibility, as defined by ICAO, addresses the ability of all airspace users to modify flight trajectories dynamically and adjust departure and arrival times to exploit operational opportunities as they occur. While the ICAO concept is restricted to operations at the tactical or flight execution stages, herein we will use flexibility in a wider sense, covering the ability to modify the trajectory at its different instantiations, from the strategic phase across the collaborative layered planning process, to the tactical phase. Flexibility will be thus understood as the ability provided by the system to modify the allocation and use of slots in order to cater for a changing environment. Flexibility can be analysed at different temporal and spatial scales.

Flexibility of allocation: ability of the system to modify the airport slot allocation to match airlines request. The current system provides some flexibility of allocation to both airlines and coordinators. After the initial allocation, each slot may be allocated as desired, rejected, or allocated but rescheduled. In the last two cases, negotiations can be carried out at the IATA conferences to find a proper solution and, if that is not possible, airlines can hand-back the unusable slots and possibly benefit from the slots returned by another airline. On the other hand, the rejection of the proposal of the coordinator involves no allocation of that slot in the next season, limiting the flexibility for airlines of being assigned in each season the slots they are interested in. Additionally, no mechanism is implemented to link dependent (origin-destination) requests. Airlines can use overbidding as a hedging strategy to mitigate the risk of not being allocated certain slots, e.g. the risk of not getting the relevant complementary slot(s) [5]. In summary, even though it provides some flexibility during the airport slot allocation phase, the current system tends to be reactionary rather than proactive. Different instruments have been suggested to improve this aspect of the system, from optimisation techniques to minimise the difference between requested and allocated slot time [38] and mechanisms for linking requests at dependent airports during the slot request process [9], [42] to the use of combinatorial auctions in conjunction with secondary trading. Defining a suitable outcome indicator to

evaluate flexibility of allocation is again a non-trivial task. Such indicator should measure how close the resulting airport slot allocation is from that which would minimise shift costs, possibly under certain equity constraints. Intermediate indicators such as the percentage of slot requests rejected by the coordinator with respect to the total slot requests for a given level of capacity usage (i.e. for a given percentage of allocation of the declared capacity) can provide useful hints about the performance of the system in this respect, but should be carefully used as they don't allow the extraction of direct conclusions about the flexibility of allocation provided by the system.

Flexibility of use (in normal conditions). The current system gives some flexibility for air carriers to adapt their offer to the actual demand. The 80-20 rule gives some margin to change the schedule once slots are allocated, allowing airlines to make certain decisions based on the commercial viability of individual flights, such as cancelling some flights on "cold" days (e.g. Christmas Day). On the other hand, some European airports have become so congested that some airlines are willing to pay other airlines to give up their slots, often for cash, but sometimes in exchange for other slots. According to [48], over 10% of the slots allocated in Europe in the 2008-2010 period were not used; unused slots are taken into account for the application of the 80-20 rule, but do not involve a fine or penalty to the carrier. Uncertain factors which may lead to late return include changes in travel demand, traffic rights, availability of the right aircraft type for each particular route, or last minute problems [48]. Here again, secondary slot trading in a transparent market would arguably increase the flexibility of slot use. Regarding indicators, similar considerations to those previously made for flexibility of allocation can be made: a suitable outcome indicator should measure how close the resulting slot use is from that which would minimise shift costs. The level of slot mobility, measured as the number of exchanges/transfers accepted against the total number of exchange/transfers requests, can also be useful to evaluate the performance of the system in this dimension.

Flexibility of adaptation to disturbances: ability of the system to adapt the final airport slot allocation to temporal, force majeure circumstances. The concept is closely linked to that of resilience, which has received much attention during the past few years, and can be loosely defined as the ability of a system to absorb disturbances and then to re-organise so as to retain its basic structure and functions. The allocation rules under the current system are not adaptable to special circumstances. When these have occurred, the regulator has made temporal amendments to the law, such the suspension of the 80-20 rule due to a decrease in air traffic demand in 2002, after the 11/9 terrorist attacks [23], in 2003 due to the Iraq war [24], or in 2009 as a consequence of the global economic crisis [26]. It is expected that under a more liberalised framework (e.g. auctions, secondary trading), the market would be able to self-adapt to these circumstances.

Flexibility of adaptation to local geographical conditions: ability to adapt to specific local needs. The current system leaves some space for local rules, especially regarding the definition of coordination parameters, the acceptance of a secondary market and the imposition of PSOs according to local needs. In principle, the reforms under consideration, in particular the introduction of market-based mechanisms, would still be compatible with providing for this type of flexibility at local level.

Interoperability

It is generally accepted that the Air Navigation System should be based on global standards and uniform principles to ensure technical and operational interoperability and facilitate homogeneous and non-discriminatory global and regional traffic flows. As far as airport slot allocation mechanisms are concerned, two dimensions are considered particularly relevant:

Interoperability of airport slot allocation systems: the European airport slot allocation system is based on IATA Guidelines, which have an international scope and are used almost all around the world except for the US. Each country or airport may add local rules, but the principle is the same. This homogenisation eases planning for carriers that operate flights between Europe and other territories where IATA Guidelines apply. This is one of the arguments used by legacy carriers against the modification of the airport slot allocation system. This performance aspect is difficult to quantify through a quantitative indicator, but could qualitatively be expressed as the level of commonality/compatibility with the IATA guidelines.

Interoperability of flight information: currently there is a lack of consistency between slots and flight plans. Flight plans are validated by the Network Manager (also known as CFMU), whereas airport slots are assigned by the coordinator of that airport. Historically there has been very little information sharing, if any, between these organisations, and airlines have often operated their flights according to a flight plan with departure and/or arrival time differing notably from the slots schedule. According to the Single European Sky principle of adopting a gate-to-gate perspective, airports need to be integrated into network planning. A common network planning, with slot assignment information available would increase the consistency between slot times and flight plans. This issue is explicitly addressed in [13], and there is also an Operational Improvement Step in the SESAR Master Plan to address that problem (OI DCB-0301) [46]. A suitable indicator to measure the level of interoperability of flight information could be the difference between slot times and take-off and arrival times in flight plans.

Capacity and Delay

The global Air Navigation System should exploit the inherent capacity to meet airspace user demand at peak times and locations while minimising restrictions on traffic flow. To respond to future growth, along with corresponding increases in other performance areas, capacity must increase. The design of the airport slot allocation system may influence capacity and delays in several respects, which we briefly discuss hereafter.

Capacity specification: while the question of whether airport slot allocation mechanisms are efficient has been the subject of different research efforts, less attention has been paid to the previous step, i.e. the optimal choice of the number of slots at a given airport or, in other words, what level of scheduled flight demand, in the presence of different sources of uncertainty, provides the right trade-off between the costs of additional delays (and possibly, environmental costs) and the benefits from additional throughput. The current practice has been criticised based on a number of arguments, such as the ample room for local interpretation or the empirical ad-hoc processes often applied. Some studies on the topic, mainly related to the US, are illustrated in [4].

Incentives for capacity expansion: another aspect that shall be taken into account in relation to capacity is the ability of a certain airport slot allocation system to create the right incentives for investment. Increases

in airport capacity devaluate slots. Some authors argue that auctions or congestion pricing could create perverse incentives for airports to underinvest in new capacity if they make profits from pricing or auctioning of scarce capacity [37]. On the other hand, it is also reasonable to argue that, with the current system, incumbent airlines which have very valuable slots at busy airports have an incentive to moderate their requests for capacity expansion [29].

Delay: with respect to a congestion-based, first-come first-served system like the one adopted in almost all US airports, a slot system not only reduces congestion through reduced throughput, but it also reduces congestion at any level of throughput by means of a more ordered, less random traffic. Additionally, the reform of the airport slot allocation system, e.g. through the introduction of market mechanisms, may lead to changes in airlines' route structures [40], which may in turn modify the level and distribution of delay.

Summary of performance

To summarise the advantages and drawbacks exposed for each KPA, Figure 7 has been created as a radar chart. The dark green line represents the weighted sum of the advantages, whereas the red line represents the weighted sum of drawbacks. The light green line at the boundary of the grid aims to represent the ideal situation, that is, a system that only has advantages, and no drawbacks. In the graph, the ideal value minus the drawback value equals the advantages. So, the drawbacks lower the total performance in each KPA, moving the “advantages” line away from the goal situation. The weights assigned to the advantages and drawbacks in each KPA are not directly related to the number of bullets but to the importance and impact on the KPA that has been estimated for each of it, based on the authors’ subjective estimation and on the analysis of the literature presented in this chapter. The resulting diagram is therefore purely indicative and just intended to provide the reader with a summary of all the advantages and drawbacks for the different performance areas presented so far.

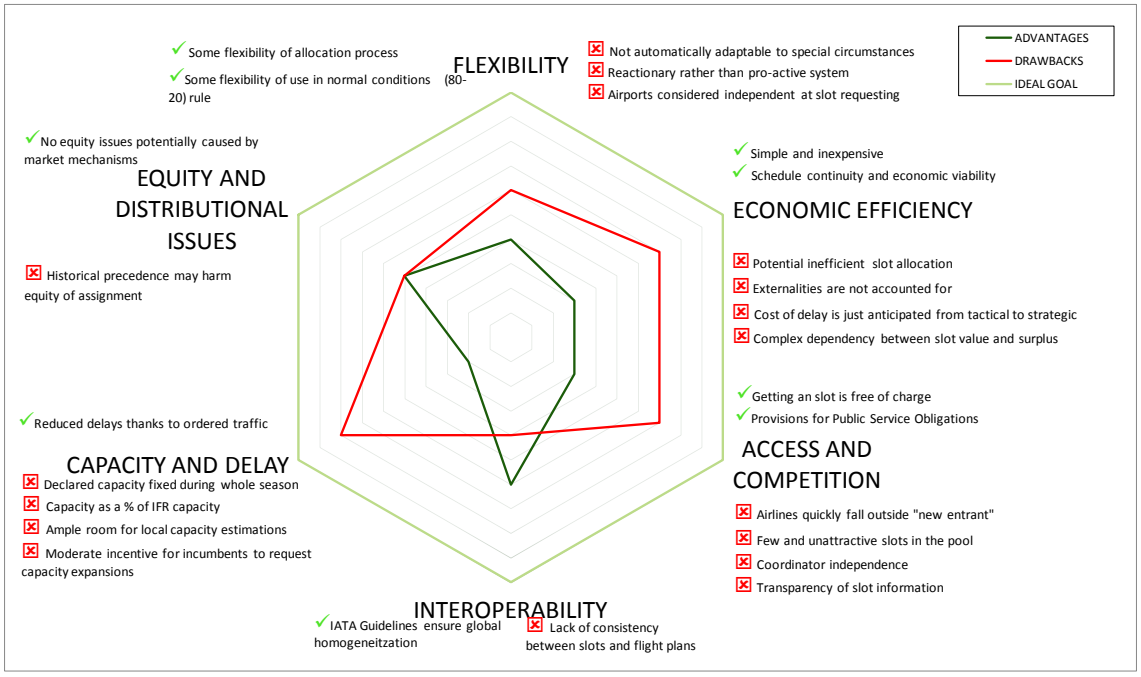


Figure 7. Advantages and Drawbacks of the current airport slot allocation system (purely indicative)

4. Analysis of stakeholders

Different stakeholders' groups take part into the system of airport slot allocation, through a process structured along a set of rules described in section 2. The following diagram summarises in a visual way the groups of stakeholders and their relations.

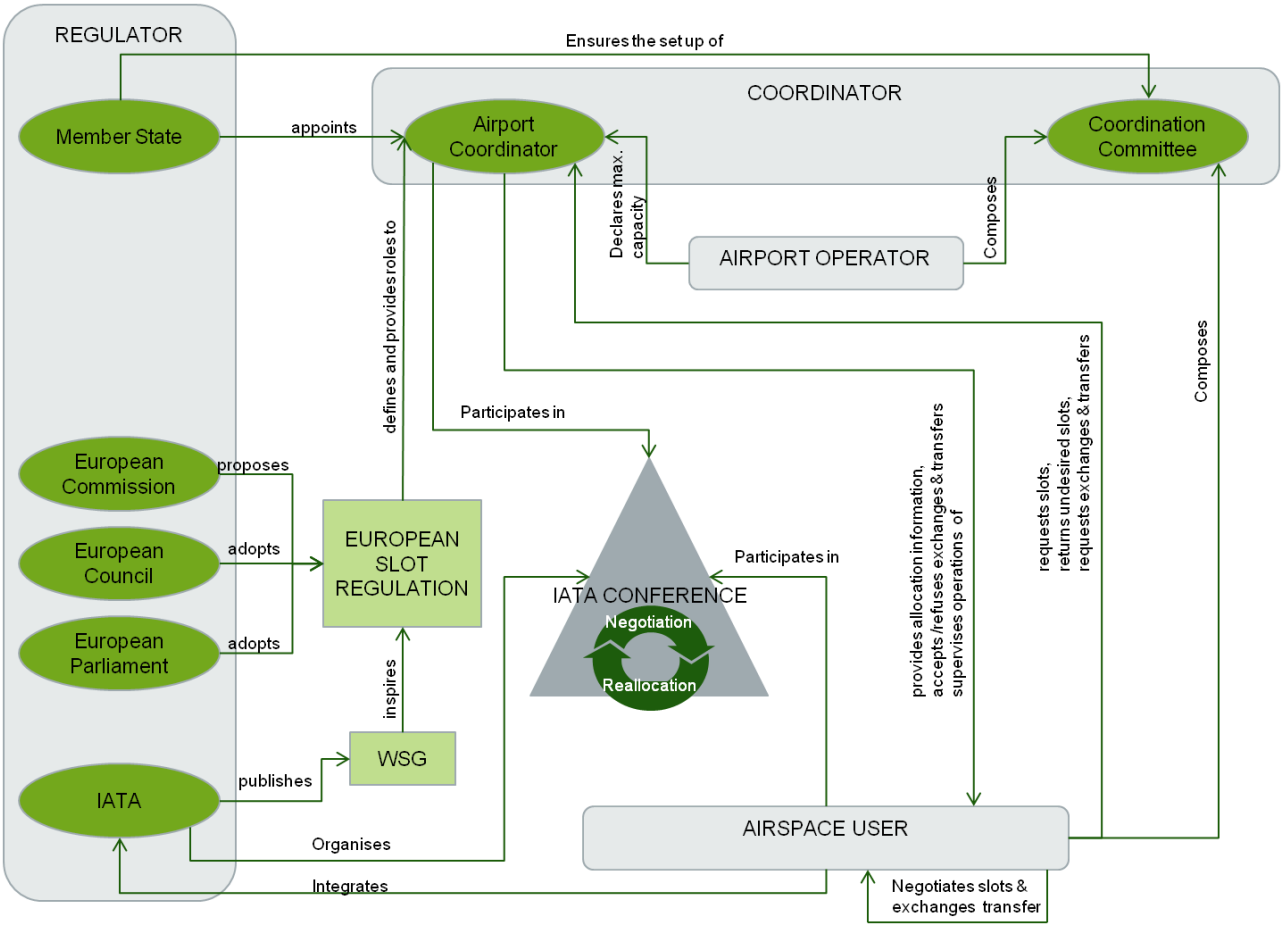


Figure 8. Groups of stakeholders and their relations

4.1 Role of stakeholders

The whole process of airport slot allocation associates each stakeholder with determined roles and responsibilities that must be exercised according to a timeline and based on the outcomes generated by mutual interactions. In order to show these relationships, the whole process has been depicted in the following business process:

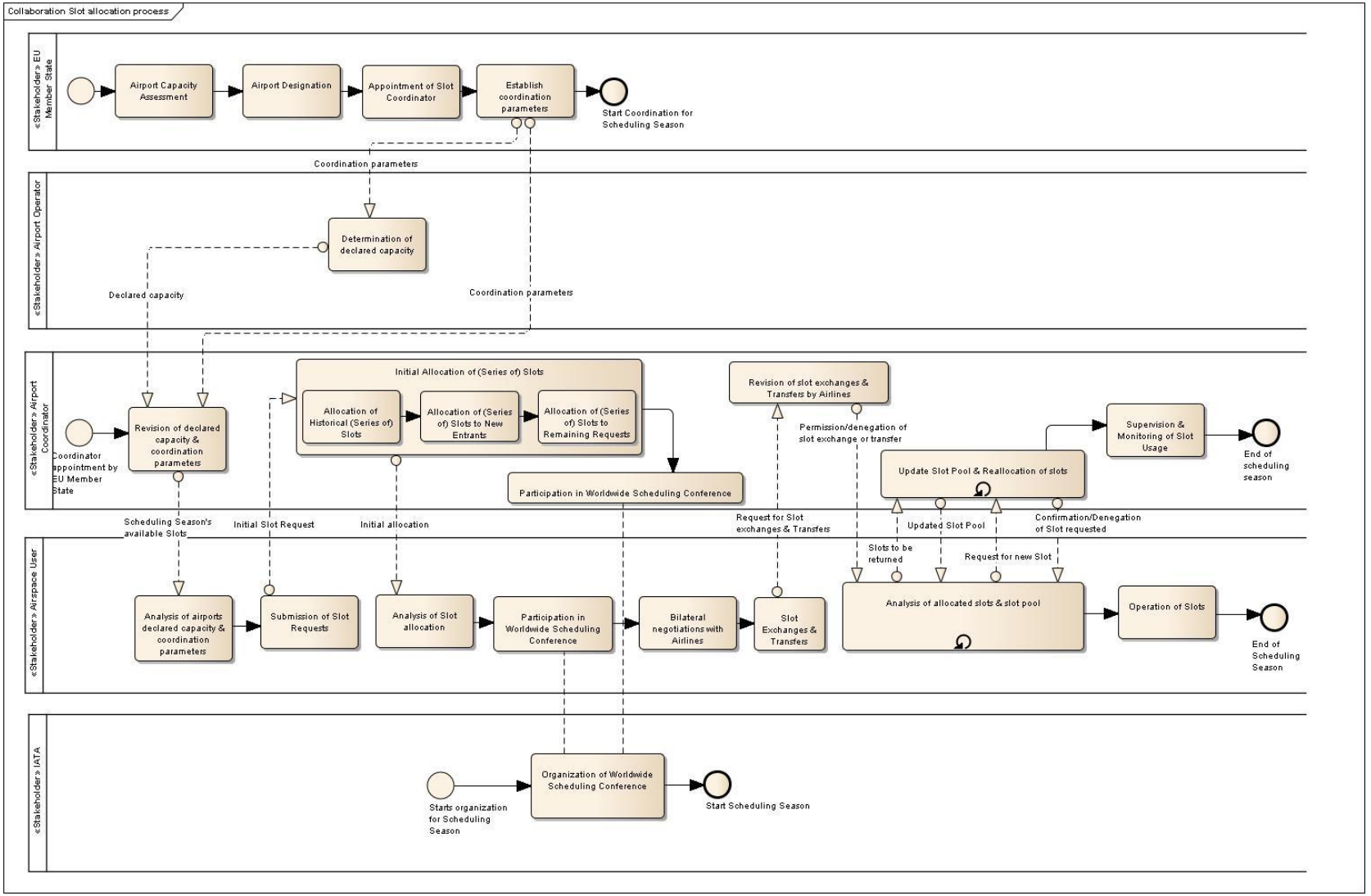


Figure 9. Airport slot allocation Business Process

In Table 9 a legend to understand the BPMN symbols used in the diagram above is introduced:

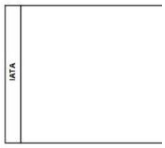
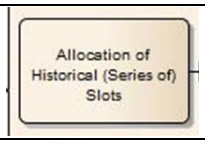
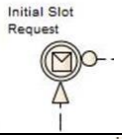
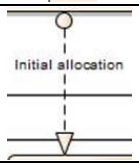
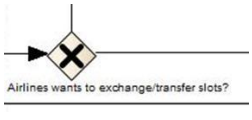
BPMN element type	BPMN element used	Example in the Models	Description/comments
Pools /swimlanes	Pool		Represent responsibilities for activities in a process. A pool represents a stakeholder performing a set of activities.
Activities	Activity		Unit of work to be performed
Events	Start Event		Start of the flow
	Message Start Event		Start of the flow once the message is received
	End Event		End of the flow
	Message Intermediate Event		Receiving message
Connectors	Sequence Flow		Sequence Flow defines the execution order of activities and events
	Association Flow		Association flow links elements in the model
	Message Flow		Message Flow symbolizes message flow across nodes or from/to a data object.
Gateway	Exclusive Gateway		Exclusive Gateway routes the sequence flow to exactly one of the outgoing branches based on conditions.

Table 3. Description of BPMN symbols

Several stakeholders are involved in the airport slot allocation process which can be classified according to their function. It must be noted, though, that the process depicted in the above figure does not include some

stakeholders which do not participate actively in decision making or the airport slot allocation process of each scheduling season. Thus, the stakeholders identified are classified in 5 different groups:

- Regulation group (in Europe): the first group of stakeholders includes those that play a role in establishing the legal framework for airport slot allocation process. This group includes: IATA (as the creator of the current international standards for the management of airport slots), European Commission, European Parliament, European Council and Member States.
- Coordination group: the second group of stakeholders includes those that coordinate airport slot allocation, monitor the process and ensure the compliance of allocated slots. That group includes airport coordinators and coordination committees.
- Airspace Users group: the next group of stakeholders includes the companies that will request and operate the slots: airspace users. This group is quite heterogeneous as airspace users are of different sizes, have different fleets and commercial strategies.
- Airport Operators group: the fourth group of stakeholders includes airport operators. Different types of operators exist as there are several different models of ownership.
- Final users group: finally, one can identify a stakeholder that does not have a direct role in the allocation process but is the final customer of airspace users: passengers.

In the following section the roles and responsibilities of each group are examined and detailed. The only stakeholders' group which is not studied in detail is the final users group, due to the fact that passengers, even if they are impacted by the airport slot allocation process, do not and cannot participate in the airport slot allocation process.

4.1.1 Regulators

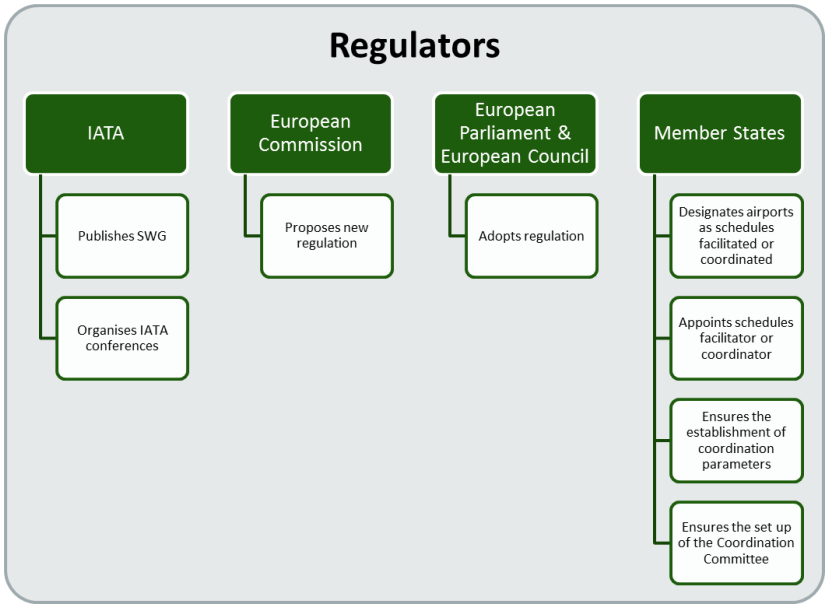


Figure 10. Regulators

IATA

The International Air Transport Association is an international industry trade group of airlines. Since 1974, IATA publishes and reviews on a regular basis the Worldwide Slot Guidelines (WSG). These guidelines provide a single set of standards for the management of airport slots, and are the result of consultation between airlines and airport coordinators. The policies, principles and processes covered by the guidelines are intended to serve as best practice for worldwide application. At the moment, every slot regulation in the world uses WSG as a baseline. Many airports (or countries) impose the local or national regulations on top of the WSG baseline.

IATA plays another important role, which is the organisation of IATA Slot Conferences, where coordinators and airspace users meet and negotiate the airport slot allocation. The conferences are held before the beginning of seasons, twice a year.

It must be noted that IATA members are airlines and therefore, IATA's interests are aligned with those of airlines. A good proof of that is the joint position that IATA and the Association of European Airlines (see chapter 0 for more details) have regarding the Commission's proposal for a change of regulation in 2011.

Nevertheless we included IATA within the Regulators since de-facto the standards proposed in the WSG constitute a set of rules and procedures universally recognised for airport slot allocation and taken as baseline when drafting Regulations (as it is the case in Europe).

European Commission, European Parliament and European Council

The European Commission, the European Council and the European Parliament play a role in establishing the European legal framework for the airport slot allocation process. The role of the Commission is the introduction of legislation into the legislative process, which gives the Commission considerable influence as an agenda setter for the European Union. The Commission proposes new regulations or amendments to existing ones, but it does not have legislative authority to enforce any legal change. Legislative power is exercised by European Council and European Parliament.

The applicable regulation is Regulation 95/93, adopted by the Council on January of 1993. Its respective amendments were proposed by the Commission and adopted by the Parliament and the Council. On 1st December 2011, the Commission proposed changes in the regulation [21] that were partially endorsed by the European Parliament in 2012. In particular, secondary trading of slots was endorsed, while the rise in the use-it-or-lose-it obligation and the proposal to lengthen series in which slots are allocated were rejected. However, these amendments have not yet converted into legislation.

The general objectives of the regulator are:

- to match capacity with demand for air transportation in all sectors (long-haul, regional, cargo, etc.);
- to ensure optimal allocation and use of airport slots at congested airports; and
- to ensure, strengthen and effectively implement airport slot allocation and use, in order to enhance fair competition and competitiveness of operators.

Member States

Member States of the European Union do not have legislative power on airport slot allocation, as regulation is established at European level. Nevertheless, the regulation grants some functions to the Member States. The most important are: designate an airport as schedules facilitated or coordinated, appoint a scheduled facilitator or airport coordinator respectively and ensure the establishment of the coordination parameters. Another obligation of the Member States is to ensure that a coordination committee is set up. The designation of an airport as coordinated shall be done on the basis of a capacity analysis and after consulting the capacity situation with the managing body of the airport, the air carriers using the airport regularly, their representative organizations, representatives of general aviation using the airport regularly and air traffic control authorities. Only if capacity problems occur for at least one scheduling period, the Member States shall ensure that the airport is designated as coordinated and shall appoint a coordinator.

For coordinated airports, the regulation makes Member States responsible for ensuring:

- the independence of the coordinator by separating the coordinator functionally from any single interested party;
- the system of financing the coordinator's activities, guarantying the coordinator's independent status;
- that the coordinator acts according to the regulation in a neutral, non-discriminatory and transparent way.

Moreover, Member States are responsible for ensuring the determination of coordination parameters for airport slot allocation. The coordination parameters are the expression in operational terms of all the capacity available for airport slot allocation at an airport during each coordination period. These must be determined twice yearly, taking into account the different types of traffic at the airport, the airspace congestion likely to occur during the coordination period and the capacity situation. The parameters shall be communicated to the airport coordinator in good time before the initial airport slot allocation takes place for the purpose of scheduling conferences.

4.1.2 Coordinators

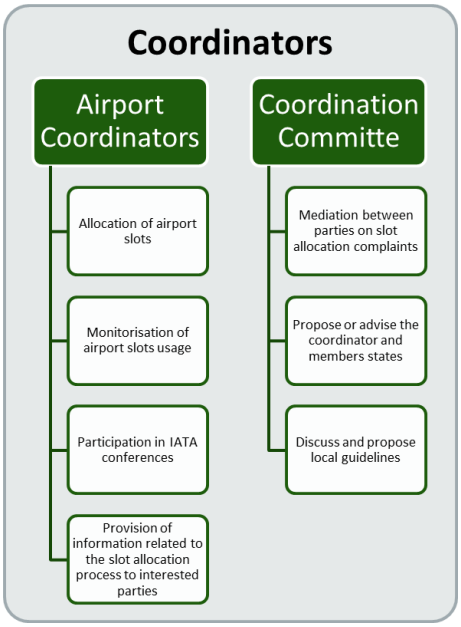


Figure 11. Coordinators

Airport Coordinators

After an airport is designated as coordinated, Member States shall ensure the appointment of an airport coordinator. The airport coordinator must be a qualified natural or legal person whose neutrality should be unquestioned. The same coordinator may be appointed for more than one airport. The responsibilities of the airport coordinator are:

- allocation of airport slots in accordance with the provisions of the Regulation 95/93;
- monitoring of the air carrier's activities related to the allocated slots usage in order to apply the regulation, particularly for the application of the subsequent season 80-20 rule;
- participation in the IATA conferences;
- provision of information related to the airport slot allocation process to interested parties in a transparent and timely manner, including reports such as airlines historical slots, requested slots, allocated slots, remaining available slots, etc.

Coordination Committee

Additionally to the appointment of an airport coordinator, the Member State must also set up a coordination committee at each coordinated airport. This coordination committee may also be appointed for more than one airport. Membership of the committee shall be open to at least:

- the airport managing body;
- the relevant air traffic control authorities;
- the air carriers using the airport and their representative organisations; and
- general aviation using the airport regularly.

Additionally, the airport coordinator and the Member State representatives shall be invited as observers to the coordination committee meetings.

The activities of the coordination committee are:

- mediate between all parties concerned on the allocation of slots complaints;
- make proposals or advise the coordinator and/or the Member State on the possibilities of increasing airport capacity, coordination parameters, allocated slots usage monitoring methods, problems encountered by new entrants, local guidelines for airport slot allocation or usage monitoring and all questions related to the airport capacity;
- discuss and propose local guidelines related to airport slot allocation and usage of allocated slots monitoring;
- submit the coordination committee discussions report to the Member State with an indication of the positions stated within the committee.

Rules shall be written by the coordination committee regarding its own activities such as elections, meetings' frequency, language used, etc.

4.1.3 Airspace Users

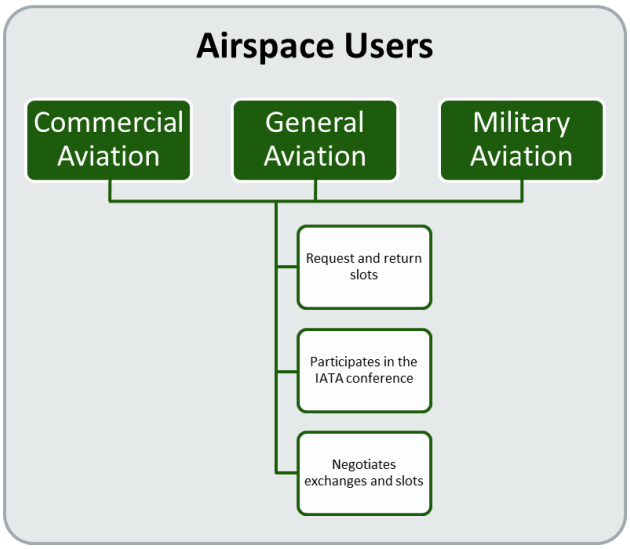


Figure 12. Airspace users

Airspace users are the end users of the airport slot allocation process as they request and operate slots. It is a heterogeneous group as there are several different types of airspace users based on different business models, which means that they have very different goals and interests. This particularity makes it impossible to produce a homogeneous characterisation of the group and an analysis for each type of airspace user must be done. It must be noted that the activities carried out by all types of airspace users related to the airport slot allocation process are the same, but the intrinsic characteristics of each airspace user may vary the frequency in which they need to carry them out. These activities are reflected in the figure above.

Commercial aviation

Commercial aviation carries passengers and/or cargo for a fee. Therefore, the aim of commercial aviation is to maximise profits. This maximization can be done in several different ways which lead to a sub-division of commercial air carriers according to their business model:

- network carriers;
- low cost operators;
- cargo operators;
- regional carriers;
- charter operators.

Network carriers

This type of commercial aviation is usually called legacy carriers. Most legacy carriers hold or used to hold a dominant position in the air market of, at least, one state. This dominant position usually comes from the status-quo before the liberalisation and deregulation of air transport market at European level: each European state had its own “major” company, which typically operated most of the flights from/to the most important airport/s.

Network carriers usually operate according to a hub-and-spoke system, through which they funnel passengers from different locations into central hubs at major airports and sort the passengers onto connecting flights to their final destinations. Most network carriers belong to international airline alliances such as Oneworld, Star Alliance or Sky Team, which allows them to offer their customers a wide range of destinations. Thanks to this, they can serve international markets that have not yet been deregulated. On the one hand, this system provides network carriers with a broad network, great geographic reach and improved load factors. On the other hand, network carriers are forced to serve some markets that are hardly profitable because its withdrawal would have a great impact on the entire network. The fact that major network carriers were funded or favoured by the state before the liberalisation and deregulation of the air transport market means that they often face hardly changeable contracts with employees and suppliers, which limits their flexibility to adapt to market changes.

Legacy carriers intend to make profit from added value services that include, among other:

- offering of differentiated classes: first, business and economy;
- high quality food and drinks during flight;
- luxury duty free products sold in flight; and
- premium services in airports for exclusive customers.

These kinds of services attract business and upper class customers which are willing to pay for them.

Network carriers are often incumbent airlines for which frequency domination is a key scheduling objective, particularly in the business segment. The more frequencies an airline offers in a given market, the greater it is the possibility that the timing of one of its departures will be close to a potential passenger desired travel time. This type of air carriers usually holds a majority of the slots in major airports, due to their history and the current regulation characteristics, which provides scheduling continuity thanks to grandfather rights.

Low cost operators

Low cost airlines exercise a very aggressive and dynamic pricing policy, with discounts and tickets in promotion, at the cost of offering less services and possibilities to their customers.

Low cost operators fly mostly (but not exclusively) to cheaper, less congested secondary airports and/or in daily time slots typically less attractive (i.e. very early in the morning or late in the evening) with the objective of avoiding air traffic delays and taking advantage of lower landing fees. Some low cost airlines may operate routes that originate or end at a major airport, but only if that the route is profitable. Unlike network carriers, low cost carriers operate with a "point-to-point" approach. That means that direct flights are encouraged, and they do not offer customers the possibility of buying two connecting flights in one single reservation. The point-to-point approach enables low cost carriers to enhance aircraft use and eliminate disruption due to delayed passengers or luggage missing connecting flights.

The main aim of low cost operators is the reduction of costs. A homogeneous fleet cuts down maintenance and training costs, but limits the range of operation types. For that reason low cost carriers tend to offer only medium to short range flights using always the same aircraft type (commonly Airbus A320 and Boeing 737 families), leaving out of their scope long haul flights. Aircraft operated by this type of air carrier are usually equipped with a minimum set of optional equipment, further reducing costs of acquisition and maintenance, as well as keeping the aircraft weight as low as possible, implying fuel savings. Faster turnaround times are achieved, maximising the use of each aircraft.

With regard to the added value services offered to the passengers, it is common to charge passengers for all extra services, considering as extra services many concepts that network carriers may offer by default, such as meals and snacks, hold luggage, priority boarding, etc. Moreover, a single passenger class is offered.

Differently from network carriers, low cost operators often do not require slot assignment for their flights, as they operate from/to regional airports that are usually not coordinated. On the other hand, low cost operators are mainly newly created air carriers with no grandfather rights in major airports, so they may benefit from their consideration as new entrants in those airports.

Cargo operators

Cargo airlines are dedicated to the transport of cargo. Two types of cargo operators exist: combined carriers and pure cargo carriers.

Combined carriers focus primarily on their passenger business. Cargo plays an important but secondary role. Their services are built on a comprehensive passenger network. Within these carriers, hub-and-spoke schemes are the predominant network configurations (with mainly one dominant hub airport) that are determined by the spatial concentration of cargo capacity at dedicated hub airports and the temporal concentration around a number of synchronised waves of flights. Combined carriers are linked to the hub airport by their passenger services and make large investments (e.g., cargo terminals) at their hub airports (long-term decision). Combined airlines transport around half of their freight on passenger aircraft as belly freight, so a strong dependency exists between passenger and freight services.

The second type of cargo operators is pure cargo airlines. Their business is entirely focused on cargo transport. They offer services on the major global markets but do not aim for a full global coverage. For instance, the network shape of Cargolux, a representative pure cargo airline, differs from combined carriers by a less concentrated and less centralised network configuration. Furthermore, the importance of single airports (e.g. the hub airport) is much smaller than for combined carriers, as pure cargo airlines are relatively uncommitted to the airport and have flexibility to change the airports and relocate services rapidly.

Regarding airport slot allocation, combined carriers have similar characteristics as network carriers as their business is focused on passenger services. In contrast, pure cargo operators are less dependent on the airport slot allocation process because they tend to operate at uncongested times and airports.

Regional carriers

Regional carriers are airlines that operate regional aircraft to provide passenger service to communities without sufficient demand to attract mainline service. Aircraft used are either turboprops or regional jets. Turboprop aircraft provide a relatively small passenger capacity (usually 70 seats or less), have a range of less than 1000 miles and a maximum cruising speed around 350 mph. Regional jets provide a similar capacity, but a longer range (1500 miles) and a higher cruising speed (over 500 mph). A disadvantage of both aircraft types relative to mainline jets is a higher operating cost per seat mile.

Regional services can be operated by network carriers as feeders to major hubs from surrounding communities, either directly or by means of a subsidiary or partner airline. Regional services can also be operated under their own brand, providing service to small and isolated communities, for which air transportation is the only reasonable link to a larger centre (i.e. a commuter airline). Lastly, regional services can be operated as an independent airline larger than a commuter airline service that operates scheduled point-to-point transit service under its own brand. The business models of regional carriers range from the traditional full service airline to low cost carriers.

Regional carriers usually connect regional airports with major airports; therefore they only need to request slots for the major airports at which they operate. This facilitates their scheduling when their requested slot is allocated but rescheduled, as they are not constrained by the need to request paired dependent slots.

Charter operators

Air charter is the business of renting an entire aircraft as opposed to selling individual aircraft seats (i.e. purchasing a ticket through a traditional airline). Tour operators, and in general companies or organisations needing to transport many people by air, are the customers of charter operators. Charter flights may be periodic (a typical case being regular charters flights between tourist areas organised by tour operators during the summer) or due to a specific peak demand (sporting events, congresses, etc.). Sometimes charter airlines offer night flights, as opposed to conventional airlines that target passengers that prefer day flights, operating from hub airports with night restrictions that do not allow conventional airlines to fully utilise the hub-spoke strategy during the night. Aircraft utilisation is relatively high compared to conventional airlines, with occupancy typically over 80 per cent. In fact, it seems clear that if a tour operator is not sure that a charter flight will be profitable, no flight will be arranged.

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Charter operators have low station costs compared to conventional airlines due to extensive outsourcing of aircraft, baggage and passenger handling. Furthermore, they have no need for out of season station staff and facilities. There is no extensive yield management, which saves expenditure on expensive staff. Tour operators print their own tickets, and because of the bulk of tickets sold to tour operators, sales cost are low, no retail sales office is necessary, and no commission is paid. Also, the expenditures on passenger service are relatively low because in charter flights there are fewer cabin staff and no business class.

Since airport slot allocation system benefits from year-round flight requests, it may be difficult for charter operations to obtain slots for specific events at most congested airports, but the fact that they prefer time slots commercially not-attractive, as during night, facilitates their operation from major airports.

General aviation

General aviation consists of civilian aircraft operations for purposes other than commercial passenger transport, including personal transport, business and instructional flying. It includes all civilian flights operating without a pre-determined schedule. General aviation therefore covers a large range of activities, both commercial and non-commercial, including flight clubs, flight training, agricultural aviation, light aircraft manufacturing and maintenance.

In order to operate at coordinated airports, an operator or a handling agent authorised by the operator must request and get assigned an airport slot for arrival and departure some hours before the planned arrival or departure time. At some airports, General Aviation operating within the time brackets as published in the latest NOTAM does not need to apply for a slot for practical reasons. These time brackets indicate certain periods during the day in which capacity is still available (normally, outside peak hours). Aircraft without prior permission could be refused landing clearance except in an emergency case. If a requested slot is not available, the closest airport slot is usually offered.

Business Aviation

Business Aviation is one specific class of airspace user within General Aviation. It is defined as “that sector of aviation which concerns the operation or use of aircraft by companies for the carriage of passengers or goods as an aid to the conduct of their business, flown for purposes generally considered not for public hire and piloted by individuals having, at the minimum, a valid commercial pilot license with an instrument rating” (definition adopted by International Business Aviation Council (IBAC) in 1998 and included in Regulation 793/2004). It uses international airports as well as regional and smaller airfields where appropriate infrastructure, such as runway length and instrument landing systems, is available. Business aviation mostly operates under IFR rules, because of the difficulties of providing a reliable service in poor weather conditions or at night under VFR.

Business aviation takes customers from the nearest airport to their starting point to the nearest airport to their destination. In that sense, increased productivity of top managers and other key staff members is the major benefit claimed by business aviation users, due to the fact that companies using general aviation aircraft for business purposes can control virtually all aspects of their travel plans. Moreover, most business flights are between cities not served by scheduled flights. That kind of operations generates more and bigger

unanticipated peaks of demand at airports than does scheduled traffic at airports of similar size because of the noticing time in advance (typically 10 hours).

While the majority of business aircraft missions are conducted on demand, i.e. on a non-scheduled basis, some companies have scheduled operations, known as corporate shuttles, which essentially are private in-house airlines. Many business operators have a fleet composed just by one or two aircraft.

According to the IBAC classification, business aviation operators can fall into three categories:

- commercial: aircraft flown for business purposes by an operator having a commercial operating certificate. Typically these are on-demand charters ("air taxis"), fractional operators, but for the new very light jets "per seat, on demand" is also proposed;
- corporate: non-commercial operations with professional crews employed to fly the aircraft (e.g. corporate fleets);
- owner operated: aircraft flown for business purposes by the owner of the aircraft.

Providing the ground infrastructure for the airport is a challenge. There are large airports that are geared to business aviation and have business models that accommodate it (e.g. Geneva), and others that specialise in it (e.g. Le Bourget or Farnborough). Elsewhere, the traffic does not justify the investment; only 11% of the 1100 airfields in Europe able to accept business aviation have fixed-base operators providing specialist ground handling, servicing and other support for business aviation [17]. With increased emphasis on revenue generation, airports with a great number of commercial air carrier movements consider these carriers as their major customers, while other users such as business aviation, whose contribution to aeronautical and non-aeronautical revenue is regarded as minor, are looked at as secondary users and as such are having difficulties in maintaining their access to the airports [36].

Military Operations

Military aviation operations concern air defence and policing flights, search and rescue, instructional and training flights, combined air operations as part of complex scenarios and UAS operations for which special use of airspace may be needed. These operations are accorded to strategic objectives dealing with national and international security and defence policies and commitments. Regarding airport slot allocation, military operations are exempted from the requirement to have a slot allocated at coordinated airports.

4.1.4 Airport Operators

Figure 13. Airport operators

The airport operator is responsible for the physical conditions on the manoeuvring area, apron and in the environs of the aerodrome. This includes assuring that the equipment and facilities provided are adequate for the flying activities which are expected to take place at that airport. The most important responsibility regarding the airport slot allocation is to declare the available capacity before each season. Also, among its responsibilities there is the coordination of airport slots with airlines and national slot coordinator. Different models of airport ownership and governance exist:

- 100% privatised;
- mixed ownership with private majority;
- mixed ownership with government majority;
- public corporation;
- independent airport authority;
- multi-level government corporation;
- government branch ownership and operations.

According to the ownership and governance model, the operators may try to maximise different parameters: total revenues, which are the sum of aeronautical and non-aeronautical revenues; total passengers or operations served; etc. Private majority airports focus more on commercial revenue and increasing their operating margin. Their main goal is to maximise the total revenues. Clearly, it is also very important for public majority airports, but these may also take into account public service and general interest considerations, that will definitely not be in the scope of private airports except for what law enforces. For example, a publicly owned airport may set very low aeronautical charges in order to incentivise operations at the airport, as a way of boosting the economy of the area. The main goal of the airport may not be to maximise its total revenues, but promoting the economy of the area.

It can be stated that all types of airports operators are interested in maximising capacity utilisation, which will increase their aeronautical and non-aeronautical revenues. While seeking the maximisation of total revenues, private airports tend to prefer long haul operations. Long haul operations usually involve more aeronautical taxes and more long haul passengers, which spend more time and thus more money in the airport commercial area (shops, restaurants, etc.). Also, all types of airport operators are very interested in being operationally efficient, especially with regard to punctuality. Passengers that suffer delays in a particular airport may associate that airport with tardiness, and decide not to come back. That is especially dramatic for airports that compete directly with other near airports, as passengers can more easily switch to a competitor. On the other hand, one can think that the higher the delays, the longer the time passengers spend at the airport and the higher the amount of money they spend. So, it seems complex to clearly identify the real interests of airports operators regarding many aspects, but clearly all of them want to maximise the effective use of capacity. Private airports are also particularly focused on increasing total incomes.

4.1.5 Passengers

Passengers are the customers of airspace users and airports. They do not have any role in the airport slot allocation system. Nevertheless, they are the key actor of the air transportation market. Passengers demand is what airspace users and airports try to satisfy. All business parameters of airspace users (routes operated, schedules, fleet, etc.) and airports (runways, facilities, etc.) are established according to the estimated demand from passengers. Therefore this demand will fully condition the desired slot portfolio of the airspace users.

There are a few key factors that passengers take into account. In general, it can be stated that passengers want low prices, high frequency and a good experience. There might be some secondary conditions, but those three are generally considered the most important. It is clear that passengers will prefer to pay a price as low as possible. High frequency demand is logical, as they have a desired take off time and demand a flight as close as possible to that time; if there is a high frequency of flights, it is more probable that a flight will fall in their desired time window. Finally, the third key factor is having a good experience, which can be defined as not suffering any mishap and not having unattended needs at any time. Examples of bad experiences are delays, passenger needs not satisfied by airport facilities, etc.

Passengers are affected by the inefficiencies of the current allocation system. When all the available capacity is not used or when a new entrant that would offer best prices fails to get slots, passengers lose opportunities. Because of that, despite not being a participating actor, passengers have interests in the performance of the system.

4.2 Stakeholders' preference and position regarding marked-based mechanisms

This section is aimed at providing an analysis of the different positions of each stakeholders group previously identified with respect to the potential introduction of market-based mechanisms into the airport slot allocation system. It is mainly based on the position papers published by their representative associations in response to the EC legislative proposal COM/2011/0827 and on other relevant material.

4.2.1 Airspace Users

Air carriers are broadly satisfied with the functioning of the current Slot Regulation, so most actors within this group do not support any changes to it. This view is shared by scheduled, charter and low cost operators and their associations. Rather they insist that the real problem is the lack of capacity at congested airports and that a revision of the current regulation would just raise costs and complexity of the system. They argue that the Commission's priority should be to ensure the proper implementation of the Regulation in all Member States [48].

The Association of European Airlines (AEA) published in November 2011 a letter to clarify its position:

- a slot mechanism that would systematically favour the operations of larger aircraft would in the end hurt network carriers and/or commuter (regional) airlines, since smaller aircraft are usually operated on thin routes to feed bigger aircraft on long haul. Furthermore, this would ultimately penalise smaller communities that would be deprived of their access to a global network;
- welcomes the introduction of secondary slot trading, in order to guarantee a common interpretation among Member States and thus ensuring that airlines willing to use it can do so without incurring sanctions;
- AEA also stresses that exchanges of slots should only take place between airlines. It opposes the fact that regional governmental authorities can buy slots through secondary trading to protect Public Service Obligations;
- AEA opposes the auctioning of new slots generated through new infrastructure, since this could raise fundamental questions about slot ownership and could distort the financing of the system (airlines already pay charges to finance airport development).

In February 2012, airspace users reacted to Commission's proposal COM 2011/827 for a revision of the slot regulation through a formal letter [35] jointly undersigned by IATA and AEA, highlighting their position:

- the formalisation of secondary trading could provide regulatory foundation and more transparency for a practice that has become beneficial in London area;
- the increased independence and transparency of coordinators is welcomed;
- the consistent application of sanctions in all Member States for the carriers not respecting the rules (e.g. no slot returning, operating without a slot) is welcomed;
- the shift from 80-20 use-it-or-lose-it to an 85-15 is opposed, since it can deprive airlines from their ability to cope with external events outside their control causing flight cancellations. This could put in stake the certainty of access to an airport and consistency of schedules. On the other hand they see

the risk that trying to incentivise too much could push airlines to operate aircraft unnecessarily, thus having a negative environmental impact. Moreover, since the 80:20 rule is used elsewhere in the world, this could cause difficulties in pairing slots at both ends of the route;

- the increase from the current value of 5 to a new one of 10 (winter season) or 15 (summer season) in the number of consecutive weeks determining a series of slots is opposed. This could hamper the flexibility of airlines to match schedule with demand;
- the introduction of a network airport for the purpose of collecting data is opposed as ineffective and adding unnecessary costs for airports and carriers;
- the introduction of a slot reservation fee is opposed because unfair and contrary to the right of cancellation allowed under the use-it-or-lose-it rule. It rather suggests the consistent application of sanctions across Member States for the misuses.

The European Regional Airlines Association published a position paper in March 2012 [27] highlighting the following points:

- opposes modifications of slot series definition;
- opposes the shift from 80-20 use-it-or-lose-it to an 85-15 one;
- does not contend the formalisation of secondary trading but highlights that it could accelerate the loss of regional connections already taking place;
- supports the practice of governments at State or Regional level being able to set aside a number of slots in order to maintain regional services (this was foreseen in [48] study but not in the regulation proposal for amendment);
- supports the mechanisms for increased independence of slot coordinators and transparency of system especially given secondary trading;
- opposes the introduction of other market mechanisms such as withdrawing and auctioning of historical slots;
- opposes the introduction of the figure of a European Coordinator;
- opposes the concept of Network Airports.

Regarding Business Aviation, a study was published jointly by ERA and EBAA (European Business Aviation Association). The study was released on 23 January 2012, and the scope was to analyse the Commission's proposal COM 2011/827 and clarify the position of European Business aviation operators. EBAA is very critical of the Commission's impact assessment of the proposal. Also, EBAA is concerned that this proposal, if adopted, would affect European regions' connectivity. EBAA recognises that:

- maintaining air service connectivity is critical for European regions to achieve their vital economic goals;
- there is clear evidence that regional airports are losing flights to hub airports under the current airport slot allocation system.

The main disagreements about EC's proposal impact assessment are:

- EC's impact assessment of the proposal calculates an increase of 0.2% and 2% in passengers in all coordinated airports. Operators using large aircraft on long haul routes will benefit from these changes, while those using small aircraft and business jets operating to regional airports will lose;
- EBAA opposes the impact assessment: it believes it is a suboptimal approach to addressing capacity problems at congested airports. Moreover, the impact assessment is not "fit for purpose" because the analysis is incomplete, partial and fails to follow current EC economic assessment techniques;
- the impact assessment accepts that regional air services would be detrimentally affected. But it fails to assess the impacts on regional airports and regional development in peripheral areas;
- due to incomplete and faulty analysis in the EC's impact assessment, the unforeseen outcome would be a detrimental impact on the less well-off regions of the EU with most of the generated economic and social benefits leaking out of the EU;
- EBAA does not agree with EC's impact assessment, which assumes that increased passenger numbers and flights at coordinated airports in the EU ipso facto result in increased economic and social benefits within the EU. On EBAA's opinion, this is a naïve assumption at best.

The specific position of EBAA on the proposal is:

- it opposes the proposal to allow airports to charge slot reservation fees, as it would be proportionately more expensive for airlines with small aircraft;
- it opposes the proposal to increase use-or-lose-it rule from 80 to 85%, as it is not needed and is expected to lead to disruption;
- it opposes the proposal to extend the minimum series length from 5 consecutive weeks to 15 (summer) and 10 (winter), as it would make it more difficult for regional airlines and business aviation carriers to maintain operations.

Negative consequences of the proposal identified by EBAA are:

- the proposed amendments would lead to a severe decline in air services between the regions and the major hubs of the EU;
- access to European hub airports and the wider aviation system from peripheral regions of the Community by regional carriers and Business Aviation operators will be placed at risk;
- the proposed amendments would lead to the eventual closure of a number of peripheral airports as they lose their thin routes connecting them into hub and spoke operations at major hub airports;
- virtually all net social benefits will be transferred out of EU;
- job losses in peripheral areas would exceed any gains at coordinated airports. The net EU situation in terms of social benefits would be a loss of over 10000 jobs. It could be considerably more over time with some peripheral regions suffering severe disinvestments;
- serious economic and social consequences for EU peripheral regions;
- major losers of the proposed policies will be: citizens in EU peripheral areas, EU regional airports, EU Regional Carriers and EU Business Aviation Operators.

Some low cost carriers (such as EasyJet) may favour the increase of the 80-20 use-it-or-lose-it to an 85-15 one, as well as an increase in the minimum length of a slot series. This in fact could help avoid the impossibility of accessing a slot (series of slots) useful to build a service on a year-round basis because it is held only for a few peak weeks. For example, a carrier wanting to operate a year-round service in the same slot (time) may not be able to access to this service because another air carrier already holds that desired slot for the peak weeks in the summer. On the other hand the extension of the series length should not be too large, i.e. making it difficult for airlines to operate on a year-round basis, especially taking into account the presence of holidays affecting the demand on business routes [44]. In the survey conducted in [48], EasyJet suggested that secondary trading would encourage new entries.

Whilst it seems that all airlines welcome the introduction of formal secondary trading mechanisms to increase transparency, they are reluctant to disclose the prices paid for the correspondent slot transactions [32] since this could reveal strategic information to competitors. The only airline to state that price information should be published was Air France [48].

Some carriers believe that alliances have had the advantage of enabling exchanges of slots between partners and ultimately led some alliances to dominate at certain airports, which further diminishes slot availability and causes problems to non-aligned carriers and new entrants like business aviation. On the other hand, other carriers argue that alliances increase competition by promoting consolidation among network carriers and allowing low cost carriers to obtain the capacity released [48].

Regarding the option of replacing the current administrative allocation of slots with an auction, there is universal opposition from scheduled and charter airlines, on the basis that it could disadvantage EU-based carriers, incentivise the entry of financial/speculative entities into the system, be inconsistent with the system used in the rest of the world, distort competition and introduce potential costs for airlines of hundreds of millions of Euros to maintain their existing operations, which they would not be able to finance. Only NetJets (business aviation) said that a one-stage auction could be the most efficient way of maximising the allocation and utilisation of slots.

Almost all airlines oppose the introduction of centralised auctions for slots that carriers want to give up, since this could reduce the willingness to sell slots thus reducing the potential benefits of increased liquidity. However NetJets supported auctions and argued that it would be more efficient than allocating slots on historical basis to incumbents, it would be good for competition and would maximise usage of slots [48].

4.2.2 Airport Operators

It is commonly accepted that current allocation systems do not get all the effective capacity to be used, which is not aligned with airport operators' interests. On the other hand, grandfather rules, particularly at very congested airports, are a guarantee for airlines to make long-term investments. That gives long term traffic certainty to airports, granting them future traffic. Traffic certainties are important for airport operators, given that uncertainties directly impact investment decisions such as runways, terminals, etc. that need robust traffic forecasts for an efficient dimensioning.

Airports and airport associations generally recognise the need for change and they are more likely than airlines to see the potential benefits stemming from a revised regulation.

As a consequence airport operators seem likely to support any measure that may put more effective capacity to use, but they will be reluctant to change those specific aspects of the regulation that, even though may be affecting the global efficiency of the system, give them low-term certainties and/or benefit them.

According to the survey conducted by [48], major airport representatives such as ACI and BAA argued that secondary trading should be explicitly permitted, subject to some conditions:

- secondary trading allowed only for historic slots and between air carriers;
- trades should be checked by the coordinator and the airport to ensure feasibility (sufficient capacity of different elements such as terminal, aircraft type) and should be transparent.

However another major airport group argued that secondary trading could distort competition by creating a barrier to entry, limit the growth of traffic, generate perverse incentives in the case of participation of intermediaries and generate operational difficulties in cases when trade is not operationally possible (e.g. between Schengen and not Schengen carriers). Manchester Airport Group stated it opposed secondary trading between airlines because it believed that the slots should belong to the airport, but it did acknowledge that secondary trading might lead to a more efficient allocation where capacity was scarce.

Airports reacted to SDG Report [48] through a formal letter [2] published by Airport Council International Europe, which represents the interests of over 400 Airports in 46 European Countries. In synthesis it supports measures that will result in the better utilisation of scarce airport capacity, to be introduced in a transparent way, taking local circumstances into account where required and without compromising grandfather rights. The main points are:

- a willingness to increase the ratio of the use-it-or-lose-it rule in favour of a more efficient use of capacity, i.e. by increasing the current slot usage rate of 80%, in order to encourage air carriers to optimise the use of slots and allow the return to the pool of those slots that will not be used effectively;
- a willingness to increase from the current value of 5 the number of weeks determining a series of slots, required for airlines to have a priority in the allocation of these slots for the next equivalent season. This could be studied in connection (alternative measure or trade-off) with the increase in the minimum usage rate at previous point;
- more competition through a new entrant priority rule, to be more flexible and locally developed to be adapted to the different local situations. The current one often does not permit airlines to build up a sufficient critical mass of services to be competitive (scarce capacity of slots in the pool);
- minimise the number of actors involved in the day-to-day coordination and clearly define the interfaces between actors, in line with the SES objectives.

Among the monetary measures to be adopted, ACI suggests the following:

- revenue neutral measures to improve the use of slots, based on a slot reservation system that would provide a monetary incentive relating to the actual use of airport infrastructure, and discourage practices such as over-bidding for slots or their late hand-back;

- exchange or transfer of slots for monetary compensation should be allowed but not mandatory, and implemented in a fully transparent manner. Part of the proceeds should be set aside for the development of new infrastructure increasing capacity. Specific circumstances related to capacity definition and projections should allow Member States to opt-out;
- it opposes the introduction of slot auctions for newly created capacity, which could have unknown consequences on the market;
- it opposes any measure allowing slot withdrawal, apart from the one derived from use-it-or-lose-it rule or enforcement measures requiring it.

On the other hand the Assembly of European Regions (AER - the largest independent network of regional authorities in wider Europe) published a position paper focusing on the possible impact on regional airports of commercial airport slot allocation mechanisms:

- primary trading via auctions of pool slots is considered as potentially favouring big air carriers with higher purchasing power in obtaining the most popular slots, excluding new entrants or smaller airlines. This in turn could hinder their sustainable development or the survival in the market. Instead of promoting competition, this may result in the strengthening of the dominant positions of existing air carriers. The disappearance of smaller air carriers from the market would result in the non-use of their slots in regional airports, and, in turn, would reduce the competitiveness of these airports;
- regional airports may lose connections, even if some smaller companies decide to take over the slots abandoned by large companies, as they may not be able to maintain their services in the long term;
- AER fully supports the position expressed by the European Regional Airlines Association.

Regarding centralised auctions, ACI and the German Airports Associations highlighted in [48] the need for a comprehensive analysis to estimate the impacts, while other Airport Operators said that it could impose unnecessary costs and administrative processes and it would probably not create possibilities for new operators or small competitors to obtain slots. In case of their introduction, the proceeds should offset future airport charges to be consistent with the principles of the Directive on Airport Charges that charges have to be cost-reflective. The German Airports Association said that auctions could be most appropriate where there was substantial new capacity, such as a new runway, and for the major hubs, where it should be ensured that sufficient capacity is available for long haul flights and not allocated to other flights that could use alternative airports.

4.2.3 Coordinators

Airport coordinators are supposed to be neutral parties in the process of airport slot allocation, therefore their interest is to ensure that correct application of the Regulation governing the airport slot allocation. Naturally they must be provided with the necessary tools, expertise and resources necessary to ensure the fulfilment of their responsibilities, but this is something that needs to be taken into account by Regulators when drafting the Regulation. On the other hand the Coordination Committee at each coordinated airport is composed of several stakeholders with different interests, it does not have interests as a unit but different interests and objectives coexist. Moreover, since the committee is a merely advisory body without final decision making power, its positions may ultimately not always be taken into account.

4.2.4 Regulators

As already detailed previously in this document, the European Commission is of the idea that the current system for airport slot allocation prevents optimal use of the scarce capacity at busy airports. For this reason it is proposing changes to the current Regulation to allow for the introduction of market-based mechanisms across the EU provided that safeguards to ensure transparency or undistorted competition are established, including greater independence for slot coordinators.

From [21], one can see that the Commission considers the introduction of market-based mechanisms for the assignment of airport slots as a way to introduce appropriate incentives and benefits that can positively influence the behaviour of players in the market (airlines), so that the available scarce capacity is used by those able to make best economic use of it.

On the other hand, Member States have expressed different positions regarding the reform. Despite the fact that their goals and interests should be aligned to those of the regulators, in the sense of ensuring optimal allocation and use of airport slots in congested airports, different opinions arise regarding the practical way of achieving them.

According to the survey conducted by [48], the UK argued that secondary trading has had significant benefits at Heathrow and Gatwick, enabling airlines to respond to changing market conditions and enhancing competition by increasing the liquidity of the slot market. It noted that, as a result of secondary trading, Virgin Atlantic was able to grow at Heathrow and low cost carriers at Gatwick, despite severe slot constraints, and that this enhanced competition. However it saw no need to amend the Regulation in this regard, since further regulation of trading could reduce the liquidity of the market.

In contrast, France argued that secondary trading would be a source of complexity and would not lead to a diverse air transport offer, or an optimal allocation; it also emphasised that, if there is trading, it should be transparent. The French competition authority stated that secondary trading would increase utilisation of slots and increase capacity, through increases in aircraft size; it estimated that the number of passengers handled at major airports in France could increase by 7%. However, it also noted that it could further strengthen the position of dominant incumbent airlines.

Spain said that the Regulation should be clarified regarding secondary trading, and that (if permitted) it should be subject to prior agreement of the coordinator and only trading of historic slots should be permitted.

Finland said that it did not favour secondary trading, but if it was introduced, ownership of slots had to be clarified.

Italy argued that secondary trading could create problems in terms of defining the legal ownership of a public good and that large carriers might be the only ones with sufficient means to participate in the slot market.

All the States responding to the [48] survey opposed the introduction of centralised auctions, since they could reduce the volume of trades, imply high transaction costs and make the process more complex. Only Sweden believed that auctions would increase transparency and the proper functioning of the market.

5. Conclusions

Airport capacity at all major European airports (i.e. the coordinated airports) is a limited resource, which demands for slot assignment procedures in order to be effectively assigned to airspace users.

Such procedures are defined at global level by the IATA Guidelines and in Europe they are regulated by Regulation 793/2004 amending Regulation 95/1993, which retains and develops the principles of the IATA slot allocation process.

The primary allocation of slots is an administrative process: Member States designate congested airports as coordinated, and slot coordinators at each of these airports seek to balance the demand for slots with the supply. The main criteria applied for airport slot allocation is historical precedence: airlines can earn historic rights (the so-called grandfather rights) to a series of slots, provided they operate the slots as allocated by the coordinator at least 80% of the time during a season (use-it-or-lose-it rule, also called 80-20 rule). Airlines can lose historic rights due to repeated and intentional slot misuse. Grandfather rights only apply to series of slots, never to single slots or other ways of grouping slots. Single slots and other groups of slots will return to the slot pool the following season. The use-it-or-lose-it rule has some exception where an airline can justify a slot usage below 80% due to exceptional circumstances.

After this first assignment to incumbent airlines and the slot reservation for PSO, a slot pool is created with the remaining slots. 50% of this slot pool is allocated free of charge by the slot coordinator to new entrant airlines (i.e. one holding less than five slots in total on that day or for an intra-EU route with less than three competitors, less than five slots for that route on that day). The remaining slots in the pool are allocated giving priority to year-round commercial air services. Airlines shall return slots that had been allocated to them but are not intended to be used before the slot return date.

Under the EC Slot Regulation, following primary allocation, slots may be exchanged one for one between air carriers or transferred by an air carrier from one route or type of service to another route or type of service operated by the same air carrier (or between parent and subsidiary companies, between subsidiaries of the same company, as part of the acquisition of control over the capital of an air carrier or in the case of a total or partial take-over). The current EC Regulation is silent as to monetary compensation accompanying slot exchanges and transfers.

Following a number of analysis and consultations carried out in the years 2010 and 2011 on how the current slot regulation is working, the European Commission concluded that the use of the scarce capacity at congested airports is not optimal. As a result, the Commission has proposed a number of changes to the current regulation, that among other things open the door to the introduction of market-based mechanisms across the EU, in an attempt to ensure that slots are allocated to those carriers able to make the best use of them.

Due to the notable impacts that such a reform could imply in terms of political, economic, operational and ultimately societal implications, it is fundamental to carefully design and analyse several possible implementation options in terms of different and sometimes contrasting performance aspects.

A number of indicators can provide useful to measure these impacts at different levels (e.g. local vs. global, quantitatively vs. qualitatively, intermediately vs. ultimately, etc.) and along different performance areas:

- Economic efficiency: this includes all allocative and productive efficiencies, which include a number of trade-offs at the time of considering some specific aspects such as the cost of operating the system, the allocative efficiency, the productive efficiency for airspace users and the cost of delay and in general the externalities generated;
- Equity and Distributional Issues: taking into account the distributional impacts of different mechanisms, as they will alter how different stakeholders gain or lose in terms of revenues and costs;
- Access and Competition: aimed at ensuring that the shared use of the airport infrastructure occurs and a safe and equitable way for all airspace users, ensuring that they all have the rights to access the resources needed to meet their specific requirements (except where special considerations are needed, e.g. significant overall safety or efficiency considerations, national defence, etc.);
- Flexibility, Resilience and Adaptability: measuring the ability provided by the system to modify the allocation and use of slots in order to cater for a changing environment, including both deviations during nominal operations and adaptability (or resilience) to circumstances implied by temporal, force majeure causes;
- Interoperability: measuring the grade to which the system is based on global standards and uniform principles, to ensure technical and operational interoperability and facilitate homogeneous and non-discriminatory global and regional traffic flows;
- Capacity and Delay: measuring the influences of the system on capacity specification, creating incentives for capacity expansion and in the in the level and distribution of delay generated.

Several classes of stakeholders intervening into the operation of the airport slot allocation system have been identified and analysed in terms of roles and responsibilities. These include:

- regulators: IATA (as producer of the WS Guidelines), European Commission, The European Parliament and the Member States;
- coordinators: Airport Coordinators and coordination committee;
- airspace users: Commercial aviation, General Aviation and Militaries;
- airport operators.

Each of them has different interests to defend and objectives to pursue in the operation of the current process of airport slot allocation and therefore a different position with respect to its reform.

Except for isolated cases (business aviation), all the airlines are in general against the introduction of auctions for primary airport slot allocation on the basis that it could disadvantage EU-based carriers, incentivise the entry of financial/speculative entities into the system, be inconsistent with the system used in the rest of the world, distort competition and introduce potential costs for airlines of hundreds of millions of Euros to maintain their existing operations

On the other hand it seems that all airlines welcome the introduction of formal secondary trading mechanisms to increase transparency, but they are reluctant to disclose the prices paid for the correspondent slot transactions since this could reveal strategic information to competitors.

Airport operators are in general also in favour of the introduction of secondary trading of slots, subject to some conditions such as the exchange just limited to historical slots and all the trades subject to check by coordinator and airports to ensure feasibility and transparency.

Some Member States on the other hand are of the position that secondary trading could introduce complexity without delivering real tangible benefits.

Other modifications of the current Regulation, such as the increase of slot usage rate of 80%, the definition of new entrants and the length of slot series, are evaluated very differently depending on the stakeholder and its direct interests.

We can conclude that the reform of the current airport slot allocation system is a delicate matter since it implies notable impacts on stakeholders from an operational, technical, economic and strategic perspective. Therefore it seems of the utmost importance to carefully design different options for implementation and to analyse them according to a number of performance metrics in several areas to ensure a real improvement with respect to the current system. We estimate that the analysis presented in this document provides important elements in this direction and will constitute a solid baseline for the design and evaluation of slot allocation mechanisms.

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Annex II. European Airport Coordinators

Responsible Member	Airport
ACD Airport Coordination Denmark	AALBORG AIRPORT
	AARHUS LUFTHAVN - TIRSTRUP
	BILLUND AIRPORT
	COPENHAGEN AIRPORT - KASTRUP
	COPENHAGEN AIRPORT - ROSKILDE
ACL International, Ireland	CORK
	DUBLIN
	SHANNON
ACL International, Poland	POZNAN
	WARSAW
ACL, Airport Coordination Limited, UK	ABERDEEN
	BELFAST CITY
	BELFAST INTERNATIONAL
	BIRMINGHAM
	BOURNEMOUTH
	BRISTOL
	CARDIFF
	DONCASTER SHEFFIELD
	DURHAM TEES VALLEY
	EAST MIDLANDS
	EDINBURGH
	GLASGOW
	JERSEY
	LEEDS/BRADFORD
	LIVERPOOL
	LONDON CITY
	LONDON GATWICK
	LONDON HEATHROW
	LONDON LUTON
	LONDON STANSTED
	MANCHESTER
	NEWCASTLE
	SOUTHAMPTON
ACN, Airport Coordination Norway AS	AALESUND VIGRA

Responsible Member	Airport
	BERGEN FLESLAND
	BODO
	HAUGESUND KARMOY
	KIRKENES HØYBUKTMOEN
	KRISTIANSAND KJEVIK
	OSLO GARDERMOEN
	STAVANGER SOLA
	TROMSO LANGNES
	TRONDHEIM - VAERNES
ACS, Airport Coordination Sweden	ÅRE ÖSTERSUND AIRPORT
	GÖTEBORG-LANDVETTER
	KIRUNA
	LULEÅ AIRPORT
	MALMÖ AIRPORT
	RONNEBY AIRPORT
	STOCKHOLM-ARLANDA
	STOCKHOLM-BROMMA
	UMEÅ CITY AIRPORT
	VISBY AIRPORT
AENA, Aeropuertos Españoles y Navegación Aérea	A CORUÑA
	ALICANTE
	ALMERÍA
	ASTURIAS
	BADAJOZ
	BARCELONA-EL PRAT
	BILBAO
	CÓRDOBA
	EL HIERRO
	FEDERICO GARCÍA LORCA GRANADA-JAÉN
	FUERTEVENTURA
	GIRONA-COSTA BRAVA
	GRAN CANARIA
	IBIZA
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	LA PALMA
	LANZAROTE
	MADRID-BARAJAS

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	MÁLAGA-COSTA DEL SOL
	MELILLA
	MENORCA
	MURCIA-SAN JAVIER
	PALMA DE MALLORCA
	PAMPLONA
	REUS
	SABADELL
	SALAMANCA
	SAN SEBASTIÁN
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	ZARAGOZA
AIRPORT COORDINATION FINLAND	HELSINKI-VANTAA
ANA - Aeroportos de Portugal	FARO
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	OPORTO
	PONTA DELGADA
ASSOCLEARANCE	BERGAMO - Orio al Serio
	BOLOGNA - G. Marconi
	CAGLIARI - Elmas
	CATANIA - Fontanarossa
	FIRENZE - Peretola
	LAMPEDUSA - Isola di Lampedusa
	MILANO Linate - Forlanini
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	ROME Ciampino - G.B. Pastine
	ROME Fiumicino - Leonardo da Vinci
	TORINO - Caselle
	VENICE - Marco Polo
	VERONA - Villafranca
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	NICE COTE D'AZUR
	PARIS CHARLES-DE-GAULLE
	PARIS ORLY
Coordinated by ACD Airport Coordination Denmark	KEFLAVIK INTERNATIONAL
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Cyprus Schedules Facilitation	LARNACA
	PAPHOS
FHKD, Airport Coordination Germany	BERLIN SCHOENEFELD
	BERLIN TEGEL
	BREMEN
	COLOGNE/BONN
	DRESDEN
	DUSSELDORF
	ERFURT
	FRANKFURT
	HAMBURG
	HANNOVER
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	MUENSTER-OSNABRUECK
	MUNICH
	NUERNBERG
	SAARBRUECKEN
	STUTTGART
HELLENIC SLOT COORDINATION AUTHORITY	ALEXANDROUPOLIS
	ATHENS
	CHANIA
	CHIOS

Responsible Member	Airport
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	IKARIA
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	KALAMATA
	KARPATHOS
	KASTORIA
	KAVALA
	KEFALLINIA
	KITHIRA
	KOS
	LEMNOS
	MILOS
	MYKONOS
	MYTILENE
	N.ANCHIALOS
	NAXOS
	PAROS
	PATRAS-ARAXOS
	PREVEZA-LEFKAS
	RHODES
	SAMOS
	SITIA
	SKIATHOS
	SKIROS
	SYROS
	THESSALONIKI-MACEDONIA
	THIRA
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	ROTTERDAM THE HAGUE AIRPORT
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	INNSBRUCK
	KLAGENFURT
	LINZ

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	VIENNA INTERNATIONAL
SCHEDULE COORDINATION MALTA	MALTA INTERNATIONAL AIRPORT
SCS, Slot Coordination Switzerland	GENEVA
	ZURICH
SLOT COORDINATION CZECH REPUBLIC	PRAGUE
SOFIA SLOT COORDINATION DPTM	SOFIA
Split Airport	SPLIT

Table 4. European Airport Coordinators

Annex III. SES II and SESAR Performance Frameworks

Performance according to Single European Sky

The EU Single European Sky (SES) is an ambitious initiative launched by the European Commission to reform the architecture of European Air Traffic Management. It proposes a legislative approach to meet future capacity and safety needs at a European rather than at a local level.

With the Single European Sky second package (SES II), a step forward was made towards establishing targets in the key areas of safety, network capacity, effectiveness and environmental impact.

The SES is based on five main pillars:

- **Legislative**: several new elements and functions are introduced to enhance overall performances, such as: the performance scheme, the Performance Review Body, FABs and the Network Manager;
- **Safety**: the new competence of EASA in ATM matters concerned with fostering safety;
- **Technology**: the SESAR programme will develop and validate the new technological solutions supporting the quantum leap in performances;
- **Airport capacity**: airports become fully integrated in the ATM system, thus permitting seamless operations between air and ground;
- **Human factor**: humans continue to be central in the operation of the system, highly supported by automation, which requires extensive validation, and the put in place of social dialogue.

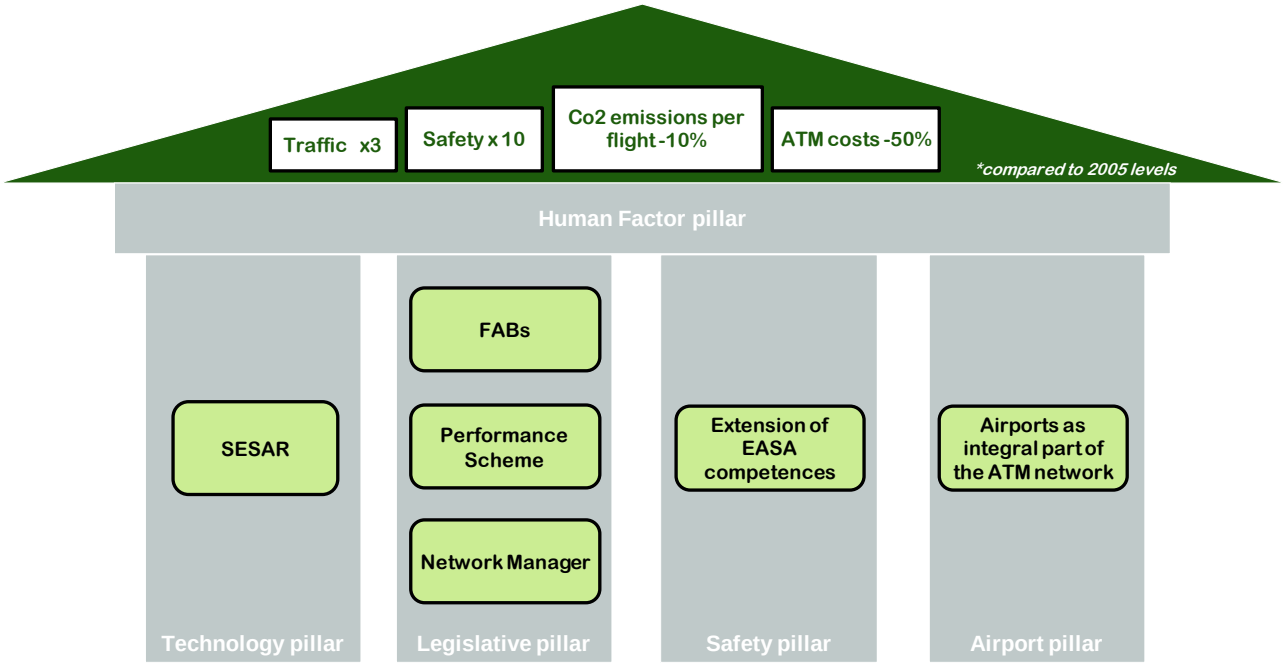

Figure 14. Main pillars of Single European Sky

The SES II Performance Scheme

As presented in Figure 14, the Performance Scheme is one of the pillars of the Single European Sky aiming at achieving the general objectives. It was introduced by the Single European Sky II package in order to:

- enhance current air traffic safety standards;
- contribute to the sustainable development of the air transport system;
- improve the overall performance of ATM and ANS for GAT in Europe, with a view to meeting the requirements of all airspace users.

The SES II Performance Scheme seeks to enhance the performance of Air Navigation Services in Europe by adopting EU-wide performance targets for fixed reference periods of 3-5 years, by requiring States to adopt binding Performance Plans that are consistent with EU-wide targets, by monitoring achieved performance against agreed targets, and by taking corrective actions as required.

The main features of this initiative are defined in the 'Performance Regulation' (EU) No 691/2010 [20] and 'Performance Regulation' (EU) No 390/2013 [22]. They provide a comprehensive, performance-driven approach for operations correspondent to the first reference period (RP1 2012-2014) and the second reference period (RP2 2015-2020), respectively.

Furthermore, the framework proposes, for each of the Reference Periods, the indicators to be measured (with an associated target or only for monitoring). For each Key Performance Area (Safety, Capacity, Cost efficiency and Environmental Flight efficiency), a set of Key Performance Indicators are defined in order to measure the performance and also to assign targets. The performance targets associated to the indicators are set both at EU-wide level and National/FAB level. These targets are legally binding for EU Member States.

The following table summarises the KPIs and PIs[1] for both reference periods, RP1 and RP2. The particularity of the KPIs is that they are performance indicators with a target assigned (text in Bold). The text in Italics makes reference to a second more granular level of local PIs (breakdown for transparency reasons/monitoring purposes).

[1] *A Performance Indicator is used for the purpose of performance monitoring, benchmarking and reviewing; while a Key Performance Indicator is used for the purpose of performance target setting.*

KPA	EU-wide KPI	RP1	RP2	Comments
Safety	**Effectiveness of safety management ('maturity')**	Monitoring	EU target FAB targets	Separate targets for NSAs and ANSPs
			National Monitoring	Indication of the contribution at national level
	Application of severity classification scheme	Monitoring	EU target FAB targets	Separate targets for NSAs and ANSPs
			National Monitoring	Indication of the contribution at national level
	Separation infringements	Monitoring	FAB monitoring *National monitoring*	
	Runway incursions	Monitoring	FAB monitoring *National monitoring*	
	ATM special technical events	Monitoring	FAB monitoring *National monitoring*	
	Application of Just Culture	Monitoring	FAB targets	
			National monitoring	Indication of the contribution at national level
	Level of occurrence reporting		FAB monitoring *National monitoring*	
	Application of automatic data recording for separation minima infringement monitoring		FAB monitoring *National monitoring*	Feasibility study + indicator development
	Application of automatic data recording for runway incursion monitoring		FAB monitoring *National monitoring*	Feasibility study + indicator development
Environmental flight efficiency	**Horizontal flight efficiency of last filed flight plan (KEP)**	EU target	EU target	NM accountable
	Horizontal flight efficiency of actual trajectory (KEA)		EU target FAB targets	
	Effectiveness of booking procedures for FUA	Monitoring	EU monitoring National monitoring	
	Rate of planning of CDRs	Monitoring	EU monitoring National monitoring	
	Effective use of CDRs		EU monitoring National monitoring	

KPA	EU-wide KPI	RP1	RP2	Comments
	Additional time in taxi-out phase	See Capacity KPA	National monitoring *Airport monitoring*	Related to outbound traffic at airports
	Additional time in arrival terminal airspace (ASMA)	See Capacity KPA	National monitoring *Airport monitoring*	Related to outbound traffic at airports
Capacity	**En-route ATFM delay**	EU target	EU target	
		National/FAB target	FAB targets	
			Local monitoring	At most appropriate level
	Arrival ATFM delays	Monitoring	EU monitoring	Related to outbound traffic at airports.
			National targets	
			Airport monitoring	
	ATFM Slot adherence		National monitoring *Airport monitoring*	Related to outbound traffic at airports
	ATC pre-departure delay		National monitoring *Airport monitoring*	Related to outbound traffic at airports
	Additional time in taxi-out phase	Monitoring		Moved to Environmental KPA in RP2
	Additional time in arrival sequencing and metering area (ASMA)	Monitoring		Moved to Environmental KPA in RP2
Cost efficiency	**Determined unit cost (DUC) for en route air navigation services (Determined unit rate DUR in RP1)**	EU target	EU target	
		National/FAB target	En route charging zone targets	
	Determined Unit Cost (DUC) for terminal ANS		EU target	This indicator applies from 2017 onwards, subject to the decision referred to in Article 10 (3) of the Performance Regulation [20]
			Terminal charging zone targets	
	Terminal unit rate	Monitoring		
	Terminal costs	Monitoring		
	Costs of EUROCONTROL		EU monitoring	Evolution of the adopted cost base compared with the evolution of the average EU-wide en-route DUC

Table 5. Summary of KPIs and PIs for RP1 and RP2 ([20] and [22])

Beyond the two established periods (RP1 and RP2), ATM needs a longer term performance perspective. This is needed to drive today's R&D activity that is developing the SESAR ATM operational concept and technology of the future system and to contribute to the long-term context for the Performance Scheme target-setting in future reference periods.

Performance according to SESAR

The management of operational ATM performance is carried out in the frame of SES Performance Scheme. On the development side, SESAR programme is the European representation of the global initiative that outlines an evolution plan of the Global ATM concept driven by the eleven KPAs defined by ICAO. Within SESAR, the European ATM Master Plan represents the highest level planning document for implementing the ATM target concept.

The relationship between the SES high-level goals and SESAR, as a technical pillar for SES, and the Performance Scheme are set out in the European ATM Master Plan [46].

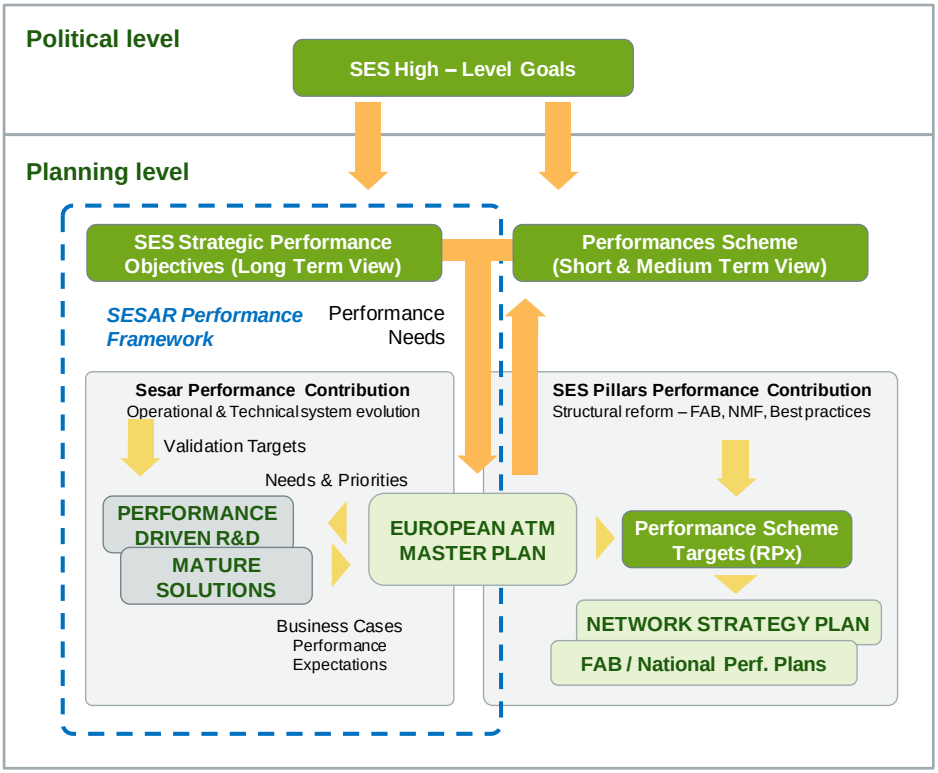

Figure 15. SES, SESAR and Performance Scheme relationship between Targets and Performance

The SES goals mentioned above are very general, so the aim of the European ATM Master Plan [46] is to re-interpret and express them in the form of SES Strategic Performance Objectives. They provide the more measurable and practical long term guidance that can serve as the basis for R&D (SESAR) and long term deployment planning. R&D is driven by the Validation Targets within the SESAR programme, which focus on the development of enhanced capabilities. Medium and short term deployment is driven by Performance Scheme targets. Long term deployment should be a continuation of medium and short term planning.

The high-level process for managing the Performance Framework is bounded at one end by the Strategic Targets from the ATM Master Plan and at the other end by the set of operational improvements that are available to achieve the performance targets. The link between these two boundaries is created by the validation targets associated to operational improvements.

The SESAR Performance Management Process has many dimensions and involves a number of projects and different stakeholders with the aim of covering both performance planning and assessment activities. It is an iterative and cyclic process composed of a top-down part (planning) and bottom-up part (assessment). The performance planning part ensures the cascading of strategic performance targets into lower level targets for the KPIs of each KPA, while the assessment part starts from the lowest level (i.e. primary project) and leads to performance assessment. This allows a gap analysis to be conducted by comparing the validation targets with the results.

SESAR Performance Framework is based on 11 KPAs, grouped according to "Societal Outcome", "Operational Performance" and "Performance Enablers" as shown below. Within the "Operational Performance" group, Efficiency, Flexibility and Predictability form a KPA sub-group called "Quality of Service" (QoS). Although this does not represent an explicit prioritisation of KPAs, the degree of external visibility does implicitly afford Societal and Operational KPAs a higher priority.

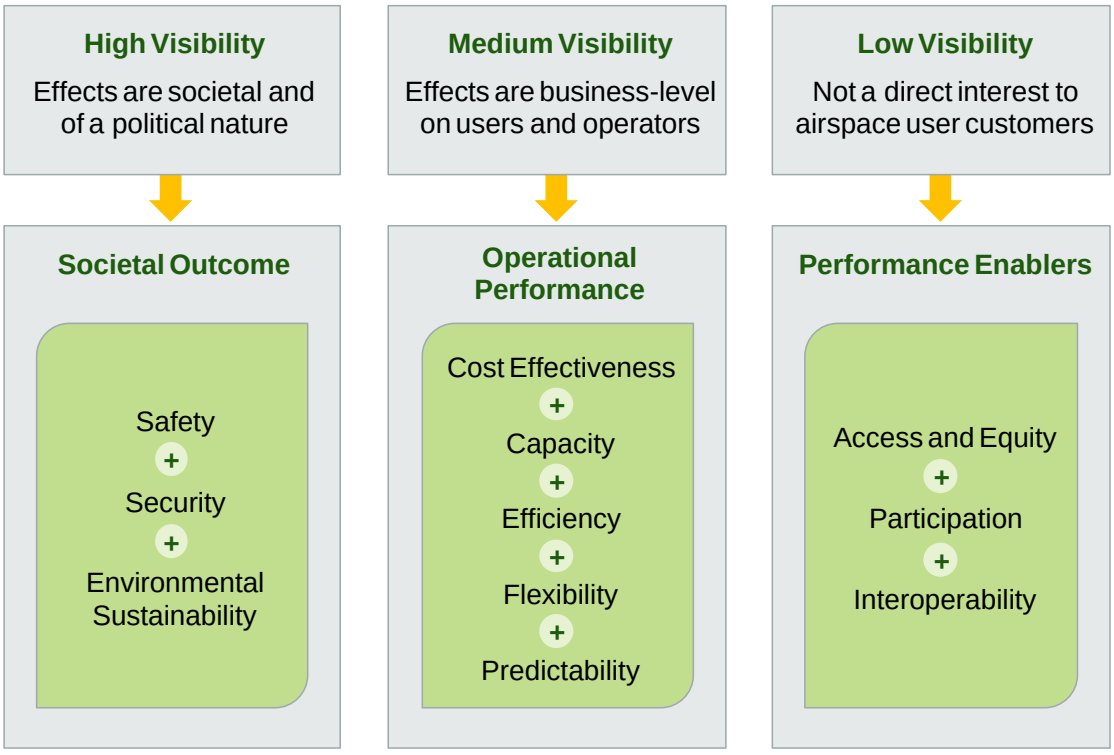

Figure 16. SESAR Grouping of KPAs (source [46])

Each of the KPAs has a particular objective and is characterised by different indicators quantitatively or qualitatively. Depending on the maturity of the improvements achieved, there are different aspects to be prioritised. The Table 6 below summarizes the KPIs used in SESAR so far.

KPA	KPI	
	Nomenclature and units	More granular components
Safety	Safety is delivered in one of six sub-models of ATM	Each model represents an accident type and being a quantifiable element of risk: • Mid Air Collision – En-route • Mid Air Collision – TMA/Approach • Runway collision • Taxiway collision • Controlled Flight Into Terrain (CFIT) • Wake turbulence accident (Wake – induced)
Environment Fuel efficiency	Fuel efficiency (Fuel burn/movement)	<u>Fuel efficiency En route</u> • Average En Route fuel burn for Great Circle trajectory • Average En Route Horizontal deviation fuel burn (reference the Great Circle Distance) • Average En Route Vertical deviation fuel burn (optimum altitude in the vertical plane)
		<u>Fuel efficiency Airport</u> • Average Taxi out fuel burn per flight • Average Taxi in fuel burn per flight • Average On stand fuel burn per flight
		<u>Fuel efficiency TMA</u> 1. Average TMA arrival fuel burn per flight 2. Average TMA departure fuel burn per flight
Capacity	Airport RWY Throughput (flight/hour)	• Departure throughput and Arrival throughput(Relative increase of RWY throughput) • Departure throughput • Arrival throughput
	Airspace Movements per volume of airspace per unit time	En Route Increased Throughput, measured as: • Number of movements per hour depending of traffic mix and traffic density • Relative change of movements (%) TMA Increased Throughput, measured as: • Number of movements per hour depending of traffic mix and traffic density • Relative change of movements (%)
Cost effectiveness	ANS cost per flight (EUR/flight)	En Route • En-Route Controller Productivity (flight hours/ En-Route ATCO hour) • Technology related cost effectiveness (ANS cost changes related to En route technological equipment and maintenance (EUR) /flight)
		TWR/TMA • Controller Productivity (flight hours/TMA ATCO hour or Movements/TWR ATCO hour) • Technology related cost effectiveness (ANS cost changes related to TMA and TWR technological equipment and maintenance (EUR) /flight)

KPA	KPI	
	Nomenclature and units	More granular components
Predictability	Block to block variability (minutes)	• Taxi in variability (Variance of the distribution of actual taxi-in duration vs. planned taxi-in duration, AXIT – EXIT) • Taxi out variability (Variance of the distribution of actual taxi-out (including ground holding) duration vs. planned taxi-out duration, AXOT - EXOT) • TMA arrival variability (Variance of the distribution of actual TMA arrival duration vs. planned TMA arrival duration) • TMA departure variability (Variance of the distribution of actual TMA departure duration vs. planned TMA departure duration) • En-route variability (Variance of the distribution of actual En-route duration vs. planned En-route duration)
Punctuality	% of Departures with < +/- 3 min vs Schedule Time due to ATM causes	• Airline Operational Factors • Airport Operational Factors • ATM Operational Factors • Recovery & Mitigation of Reactionary Delay

Table 6. KPIs defined and used in SESAR

Main similarities between KPAs and KPIs

Below, the reader can find a number of considerations and conclusions referring to the correspondence between the concepts associated to KPAs and KPIs within the different frameworks introduced in previous two sections.

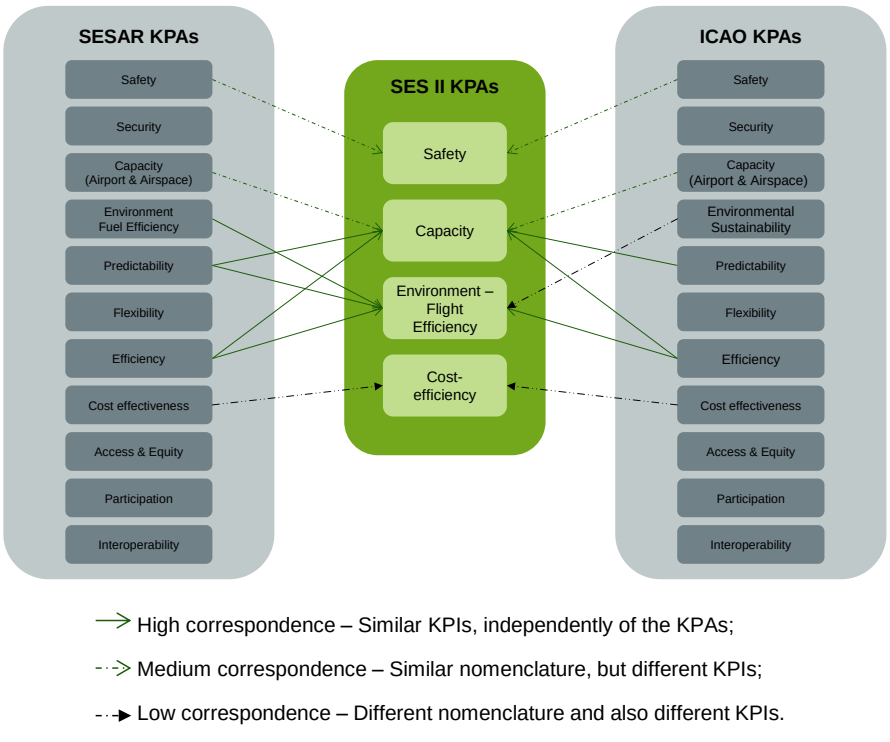

Figure 17. Relationship between KPAs

Figure 17 represents a first approximation of the relationships between the KPAs identified in different performance frameworks. The initial KPAs are defined by ICAO. Starting from these performance areas, SESAR adopts their definitions and adapts them to its context. The main differences appear at a lower level, when the indicators and targets are set for each KPA. There are different views of how a KPA can be quantified, establishing indicators and setting targets within each performance framework.

The nomenclature used in the frameworks is almost identical, but the indicators defined for each KPA are slightly different. These differences have been grouped in three categories, depending on their approach to the key performance indicators set in the Performance Scheme [20]:

- High – when, independently of the KPA, at least one KPI follows the definition established in the Performance Scheme.
- Medium – when the KPAs have the same nomenclature, but are measured through different KPIs.
- Low - when the KPAs have different nomenclature and are measured through different KPIs.

The KPAs that do not have any type of correspondence are the ones without any KPIs associated or that do not have any similarity with the KPIs present in the EC regulation Performance Scheme. Table 7 exposes the similarities between the KPAs, pointing out their correspondent targets.

KPAs	SES II Performance Scheme		ATM Master Plan/SESAR Validation targets (Targets set by the ATM Master Plan)		ICAO
	Definition	Targets for RP1	Definition	Targets	Definition
Capacity	Definition: No formal KPA definition provided in the Regulation Focus: The scope covers en-route and airport/ terminal flight phases and the focus is ATFM and ANS related delay.	En-route ATFM Delay per flight (all causes): • 0.5 min per flight	Definition: Ability of the ATM system to cope with air traffic demand (in number and distribution through time and space). It relates to the throughput of that volume per unit of time, for a given safety level.	Airspace Capacity IFR Movements per airspace volume per unit time (most challenging environment): • Increase by 200% by Concept Step 3 with respect to 2005 Airport capacity Runway throughput: • +20%[2]	The inherent capacity to meet airspace user demand at peak times and locations while minimizing restrictions on traffic flow.

[2] *Based on the SESAR Definition Phase target for single-runway airports of developing a capability to increase throughput from the 2005 "Best-in-Class" (BIC) of 50 movements per hour to a throughput of 60 per hour.*

KPAs	SES II Performance Scheme		ATM Master Plan/SESAR Validation targets (Targets set by the ATM Master Plan)		ICAO
	Definition	Targets for RP1	Definition	Targets	Definition
Cost-efficiency	Definition: No formal KPA definition provided in the Regulation Focus: ANS costs per flight.	Determined Unit Rate for En-route ANS (€ per Service Unit) for EU+23: • Reduce by 10.5%, €53.92 in 2014 (€2009 prices)	Cost-effectiveness Definition: Cost of gate-to-gate ATM in relation to the volume of air traffic that is managed. Focus: ANS costs per flight.	Direct ANS Cost per Flight: • Reduce by 50% by Concept Step 3 with respect to 2005 – from €800 to €400 per flight	Cost-effectiveness The cost of ATM service to airspace users. It covers 2 areas: • Direct Cost of Gate-to-Gate ATM • Indirect Costs (attributable to non-optimal gate-to-gate ATM performance)
Environment	Environmental flight efficiency Definition: No formal KPA definition provided in the Regulation Focus: The main issue is the environmental impact of aircraft operations managed by the ANS.	Excess route distance of the last filed flight plan vs. GCD: • 0.75 percentage point reduction.	Environmental fuel efficiency Definition: Role of ATM in the management and control of environmental impacts. Focus: Reduction of adverse environmental impacts (average per flight); to ensure that air traffic related environmental considerations are respected;	Average fuel burn per flight (related to ATM factors): • Reduce by 10% by Concept Step 3 with respect to 2005	The contribution of the ATM system to the protection of the environment by considering noise, gaseous emissions, and other environmental issues during the implementation and operation of the ATM system.
Safety	No targets, only monitoring of Safety KPIs		Definition: Addresses the risk, the prevention and the occurrence and mitigation of air traffic accidents. Focus: Accidents and Incidents	Number of accidents: • 40% reduction in accident risk per flight hour	Safety is the highest priority in aviation, and ATM plays an important part in ensuring overall aviation safety

Table 7.Comparison between KPA/KPIs and correspondent targets

There are commonalities and some significant differences in the indicators and the targets of these performance frameworks. SES Performance Scheme targets constitute the basis for some very specific binding targets on stakeholders. The notion of accountability for performance outcomes is much stronger in the Performance Scheme. On the other hand the validation targets in the ATM Master Plan and SESAR do

[3] *EU+2 means the 27 States that belong to the European Union + Norway and Switzerland*

not need to be concerned about accountability to the same extent as they relate to overall “ATM system” performance which encompasses all stakeholders in a much more integrated manner. All these targets are pointing towards the same objective, contributing to the achievement of the SES high-level goals.

Table 8 includes the KPIs and PIs defined in SES II Performance Regulation, together with their correspondences in SESAR, i.e. KPIs used in SESAR with a common or similar metric. Here again, the SES II Performance Scheme is used as a pivotal reference and all considerations and conclusions are grouped according to the KPAs defined in it.

SES II Performance Scheme		SESAR		Similarities
KPA	**KPI/PIs**	**KPA**	**KPIs**	
Safety	Separation infringements Runway incursions	**Safety**	Risk model which represent accident type and elements of risk: • Mid Air Collision – En-route • Mid Air Collision – TMA/Approach • Runway collision • Taxiway collision • Controlled Flight Into Terrain (CFIT) • Wake turbulence accident	The view in SESAR is focused on accidents, whilst in SES more on their prevention.
Environmental flight efficiency	Horizontal flight efficiency of last filed flight plan - KEP (comparison between the length of the last filed trajectory and the great circle distance, summed over all IFR flight within or traversing European airspace and measured in NM) & Horizontal flight efficiency of actual trajectory -KEA (comparison between the length of the actual trajectory and the great circle distance, summed over all IFR flight within or traversing European airspace and measured in NM)	**Environmental Fuel efficiency**	Average En route horizontal deviation fuel burn per flight (kg/flight)[4]	Direct link between route extension and fuel burn, given the characteristics of the aircraft. The reference coincides in both situations, being the Great Circle Distance.
		Predictability	En route variability (Variance of the distribution of Actual En Route duration vs Planned En Route duration, min)	Extra time in en route will be partly due to a trajectory deviation due to tactical ATC intervention.
	Additional time in taxi-out phase (actual time –unimpeded time in low traffic, in mins/departure)	**Environmental Fuel efficiency**	Average fuel burn in Taxi out per flight (kg/flight)	Direct link between time and fuel burn, given the characteristics of the aircraft.
		Predictability	Taxi out Variability (Variance of the distribution of Actual Taxi out duration vs. Planned Taxi out duration, min)	Direct link between additional taxi-out time and its variance over a certain period.
	Additional time in arrival sequencing and metering area - ASMA (ASMA transit time – ASMA transit time in low traffic periods, minutes/arrival)	**Environmental Fuel efficiency**	Average TMA arrival fuel burn per flight(kg/flight)	Direct link between time and fuel burn, given the characteristics of the aircraft. ASMA however is defined as a virtual cylinder of 40NM around the airport: no exact correspondence with TMA.

4 The reference is considered the Great Circle Distance in the horizontal plane and the optimum altitude in the vertical plane.

SES II Performance Scheme		SESAR		Similarities
KPA	KPI/PIs	KPA	KPIs	
		Predictability	TMA arrival variability (Variance of the distribution of Actual TMA arrival duration vs Planned TMA arrival duration, min)	Direct link between additional ASMA time and its variance over a certain period. ASMA however is defined as a virtual cylinder of 40NM around the airport: no exact correspondence with TMA.
	Effectiveness of booking procedures for FUA (ratio of time that airspace was allocated and the airspace that was used)	Capacity	Throughput (Movements per volume of airspace[5] per unit time)	Direct link between movements-in and usage-of a restricted area.
Capacity	En-route ATFM delay (CTOT – ETOT, min)	Punctuality	% of Departures with < +/- 3 min vs Schedule Time due to ATM causes (Difference in Actual Departure calculated as ATOT - STOT)	Partial consistency between ATFM delays and departure delay caused by ATM.
	ANS related local delay at gate (pre-departure delay (min)/ outbound IFR flight)			Partial consistency between gate delays caused by ATM and departure delays caused by ATM.
Cost efficiency	Determined unit cost (DUC) for en route air navigation services (Determined unit rate DUR in RP1) (En route determined costs/forecast traffic expressed in En route service units)	Cost effectiveness	ANS costs per flight	Direct link between DUC and ANS costs. By dividing it by total number of flights the value of the indicator should result very close.

Table 8. Comparable KPIs between SES II and SESAR

It is evident that the SES II Performance Scheme has been defined and focused on the performance of the operational ATM system as a whole. Within SESAR, there is a different approach to Performances, due to the definition of targets for the development of an appropriate operational concept to be measured in a validation environment. This leads to the utilisation of different KPIs, but without losing the alignment as far as it is practicable and desirable in light of the specific objectives of the SES II Performance Scheme.

5The "volume of airspace", for Step 1 Validation Targets in SESAR, is used as a group of sectors.

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