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AIR TRAFFIC FLOW AND CAPACITY MANAGEMENT AND A NEW PROCESS FOR SLOT MESSAGE PROPOSAL

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ABSTRACT

Air traffic flow management practices are managed by EUROCONTROL (European Organisation for the Safety of Air Navigation) in ICAO (International Civil Aviation Organisation) Europe Region for a long time. While managing these practices, EUROCONTROL aims to enhance service quality and performance, manage demand-capacity imbalances and develop ATFCM (Air Traffic Flow and Capacity Management). ATFCM practices are processed in 4 phase. ATFCM practices are airway and ground slot allocations. Aircraft operators are informed by message system in slot allocation. Within the scope of this study, it is clearly tried to propose that changing message arrangement to give more flexibility to the slot allocation procedures and discussing advantages and disadvantages of this arrangement.

INTRODUCTION

In ICAO Europe Region, air traffic flow management practices are managed and developed with enhancing new conditions by EUROCONTROL. There are 3 main objectives to make it right away for ATFCM. These objectives are,

- Enhancing service quality and ATM system performance,
- Managing demand and capacity imbalances in the system and
- Developing ATFCM in the light of these objectives [Eurocontrol, 2016a].

ATFCM which is started to mainly meet these objectives has 4 practice phases. These phases [Eurocontrol, 2016a] are,

- Strategic flow management,
- Pre-tactical flow management,
- Tactical flow management and
- Post operational analysis.

These phases are provided good combination with shareholders and applicators. So, it should fit the purpose of air traffic management. At this stage, the content of these phases should be explained.

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- Strategic flow management: This phase starts to run 7 days or more prior to the operation. The focus of this phase is about Research-Plan-Coordination. The output of the strategic flow management is NOP (Network Operation Plan). Within the scope of this stage demand/capacity imbalances are researched and if any non-suitable condition was found, NM (Network Manager) becomes responsible for it and strategic ATFCM performs the planning.
- Pre-tactical flow management: This phase starts to run 6 days before the operation. Planning and coordination issues are performed in this stage. ADP (ATFCM Daily Plan) is output of this phase. In addition, these plans are distributed via ATFCM Notification Message via NOP Portal.
- Tactical flow management: It begins on the day of operation. If there are any disturbances against the ADP and it has to be corrected/regulated, these situations are minded out real-timely. These disturbances can vary as staff issues (strike etc.), weather condition etc. Hence, original plan should be modified to fix disturbances and get them to the advantage positions.
- Post-operation analysis: This stage is performed after operation completed. It is done to get feedback of operations. Feedback is also collected by airline companies. Expected results and real results are compared at this stage [Eurocontrol, 2016a].

Air traffic flow and capacity management is supported by some programs and projects which are coherent with ATFCM phases. Nowadays, there are lots of projects which are supported by EU and Eurocontrol. These projects contain methods to solve capacity and bottleneck issues for limited airports and airspaces. Hence, there are 2 main methods which are still stood to test of time. These methods are “Slot allocation” and “Rerouting”. Rerouting is briefly used for allocating new route or flight level to the issued flights. Slot allocation will be explained next chapter. There are some kind of solutions for capacity shortfalls in Figure 1 [Eurocontrol, 2016b].

Figure 1: ATFCM Solutions to capacity shortfalls

Slot Allocation

Slot allocation can be assumed that place-time allocation for specific users in specific times via various operation messages. In detail, slot allocation is specified times for landing-departure operations in international airports.

In these days, slot allocation process allows semi flexible usage. Any flexibility can't be made except of weather, strike etc. The slot allocation contains a message process which starts with sending the flight plan by airline operators.

The methodology of this study will be changing message process to give more flexible usage to the system. If the message process can be changeable in some regulations, slot allocation system may be more flexible and practical.

Within the scope of this study, it is tried to propose giving more flexibility to the message offers and encouraged to discuss advantages and disadvantages of this proposal.

Type of Slots

In ECAC region, there are ground slots and airway slots. These are 2 methods to regulate traffic stacks by focusing on demand capacity balancing. Before ground slot which is strictly purpose of this study, it is decent to mention about airway slots.

Airway slot: Airway slot is a way of regulation the overhead traffic flow. In order to provide this, airlines get a time to over a location, time for entrance to the issued sector. In this way, traffic flow is getting rapid and regular view. There are also auxiliary methods to regulate the traffic flow in an airspace. These are "Level Capping", "Rerouting" etc.

Level capping is the level restriction for specific air route in ACC (Area Control Centre). By this way, in specific routes, flight levels are occupied in the exact restrictions by airlines.

Rerouting is a way to relax traffic flow in ACC and sectors. This method may be used to provide route restriction (for military operations, air events etc.) or ease the capacity of sectors [Eurocontrol, 2016b].

Ground slot: The other slot type is ground slot which is focal point of this study. This slot method aims to give delays to the airlines on the ground (in the departure airports). The process of this slot starts with filling flight plans and examining the flight plans according to the capacity constraints in the issued airports. The factors and process is given in Figure 2.

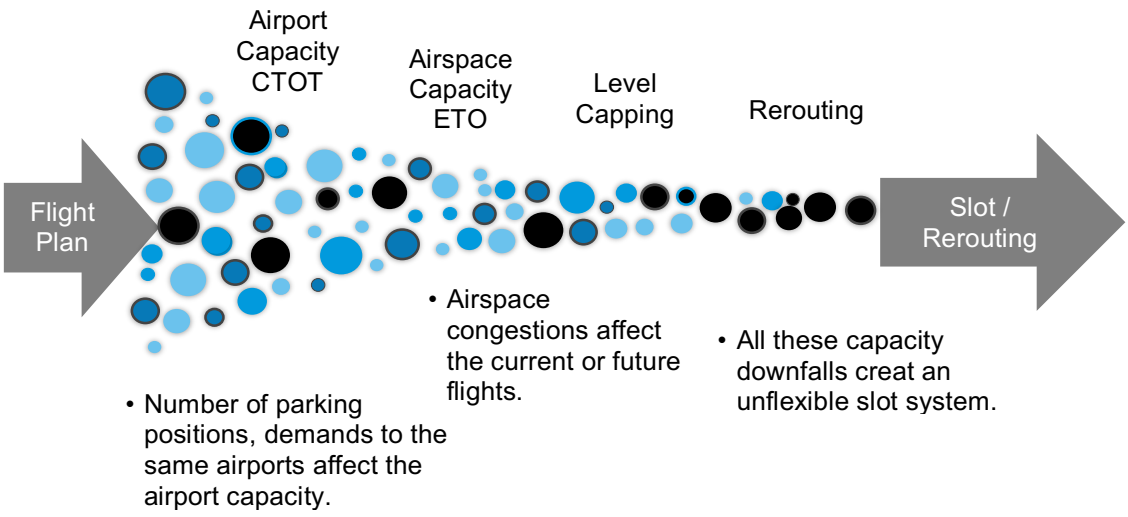

Figure 2: Current situation process and factors

More effective slot allocation process has very important role in air traffic flow. According to the research, namely Task 4: European Air Traffic in 2035, 1.9 million flights can't depart due to parking position restrictions in 2035 [Eurocontrol, 2013]. Hence, slot allocation is really important, however, slot allocation system examines the delay process (Figure 3).

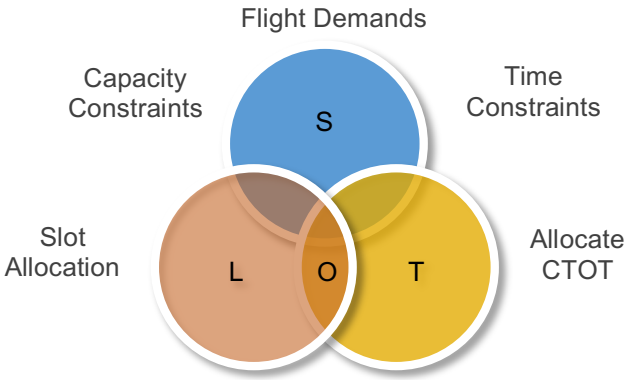

Figure 3*:* Slot allocation overview

Unrefined explanation for slot allocation process and effects is;

- Demand and capacity are compared.
- Issued flight gets a CTOT (Calculated Take-off Time). Airline has to apply this time window.
- With this time window, flight comes to the narrower area due to time.
- If airline is unable to apply this time window, airline has to face with penalties of it.

It is exactly understandable that slot allocation holds the demands in a unbreakable ring in most situation. It also gives the airlines some penalties if the airline can't make this slot real.

Slot allocation presents solutions by restricting the flexibility due to capacity constraints.

PREVIOUS STUDIES

Zografos, Salouras and Madas researched about requested and allocated slots. It is achieved to minimise slot time among requested and allocated in 2-6 months before the scheduling season [Zografos et.al, 2012].

Another study is aimed to reduce delay by taking aircraft operators schedule buffer into account. This provides to reduce delay propagation and improve slot adherence in the airport [Ivanov et. al, 2017].

METHOD

Before the methodology of previous study, it is good to know current process of slot allocation. Slot allocation is managed by NM (Network Manager) in Brussels, Belgium. NMOC (Network Manager Operation Centre) manages the airspace data management, flight plan process and air traffic flow and capacity management. In order to accurate process, flight plan should send accurately. Flight plan must be send before 3 hours to EOBT (Estimated Off-Block Time). Flights which departed from ATFCM area or departed adjacent ATFCM area and enter to the ATFCM area must send flight plans. In this phase, airlines must pay attention not to send ghost or duplicate flight plans. These are giving problem to the NM what has to determine the demands accurately [Eurocontrol, 2016a]. In the light of these information, CASA (Computer Assisted Slot Allocation) system creates a slot list. System determines the flights which enter the area. They are lined up according to the entrance time. After that, TOT (Take-Off Time) are given to the flights. After all, Network Manager send messages to the issued flights to inform them about slots and CTOTs [Eurocontrol, 2016a].

These messages and definitions are in Table 1 [Eurocontrol, 2016a];

- SAM (Slot Allocation Message)
- SRM (Slot Revision Message)
- SLC (Slot Requirement Cancellation)
- SIP (Slot Improvement Proposal)
- SMM (Slot Missed Message)
- SPA (Slot Improvement Proposal Acceptance Message)
- SRJ (Slot Proposal Rejection Message)
- RFI (Ready for Improvement Message)
- SWM (SIP Wanted Message)
- REA (Ready Message)

Table 1. ATFCM Slot Messages and Definitions

Slot Messages	Definition
-TITLE SAM -ARCID AMC101 -IFPLID AA12345678 -ADEP EGLL -ADES LMML -EOBD 160224 -EOBT 0950 -CTOT 1030 -REGUL RMZ24M -TTO -PTID VEULE -TO 1050 -FL F300 -TAXITIME 0020 -REGCAUSE CE 81	Used to inform aircraft operators and air traffic services of the Calculated Take-Off Time (CTOT) computed by CASA.
-TITLE SRM -ARCID AMC101 -IFPLID AA12345678 -ADEP EGLL -ADES LMML -EOBD 160224 -EOBT 0950 -NEWCTOT 1005 -REGUL RMZ24M -TTO -PTID VEULE -TO 1025 -FL F300 -TAXITIME 0020 -REGCAUSE CE 81	Next updates may be notified via the Slot Revision Message (SRM).
-TITLE SLC -ARCID AMC101 -IFPLID AA12345678 -ADEP EGLL -ADES LMML -EOBD 080901 -EOBT 0945 -REASON OUTREG -TAXITIME 0020	If CTOT is no longer subject to an ATFCM restriction.
-TITLE SIP -ARCID AMC 101 -IFPLID AA12345678 -ADEP EGLL -ADES LMML -EOBD 080901 -EOBT 0945 -CTOT 1030 -NEWCTOT 1010 -REGUL UZZU11 -RESPBY 0930 -TAXITIME 0020	The SIP proposes a NEWCTOT. Response is required from the AO.
-TITLE SMM -ARCID AMC101 -ADEP EGLL -ADES LMML -EOBD 080901 -EOBT 0945 -CTOT 1020	Used when a slot time given in the SAM cannot be achieved.
-TITLE SPA -ARCID AMC101 -ADEP EGLL -ADES LMML -EOBT 0945 -NEWCTOT 1010	Positive response to a Slot Improvement Proposal (SIP) message.
-TITLE SRJ -ARCID AMC101 -ADEP EGLL -ADES LMML -EOBT 0945 -REJCTOT 1010	Used when AO cannot comply with a Slot Improvement Proposal (SIP) message.
-TITLE RFI -ARCID AMC101 -ADEP EGLL -ADES LMML -EOBD 080901 -EOBT 1030	Used to change the flight's readiness status from SWM (RFI NO) to RFI.

-TITLE SWM -ARCID AMC101 -ADEP EGLL -ADES LMML -EOBD 080901 -EOBT 1030	Used to indicate that it cannot accept SRM if an improvement is possible.
-TITLE REA -ARCID ABC101 -ADEP EGLL -ADES LMML -EOBD 080901 -EOBT 1030 -MINLINEUP 0005	For flights having received their slot and can depart before their CTOT.

This method gives to the aircraft operators alternative CTOT in the message system. In order to realize it, process of message system may be changed. Thereby, system can give alternative CTOT time in the beginning of process with SAM message to the aircraft operators. So, aircraft operators can make a choice about departure times. Otherwise, aircraft operators already had a slot allocation and it is valid until it is required to change. With this perspective, aircraft operators could be chosen to change their issued CTOT to the alternative CTOT.

Main goal of this new approach is the giving to the aircraft operators alternatives to ease parking positions and provide more flexible slot system. The new process is applied by creating one target airport and 4 source airports as in Excel sheet. Then, the alternative CTOTs were tried to determine usage and benefits of it. Firstly, suitable flights were found then, offer them to the new CTOT (before 25 minutes to the given CTOT) and there were 2 new-empty parking positions that are held to use by aircraft operators thanks to this new CTOT. In this way, it may be recess parking positions for 2 extra aircrafts for every time zone in a day (1 hour). Another side of the results are about passenger numbers. The number of passengers increased as +1.327.140 extra in one year. It is really good traffic numbers if the traffic vision of 2035 is thought [Çınar and Demirel, 2017].

CONCLUSION and DISCUSSION

In theoretical and basic concept of this study in Excel programme, the effect of this message procedure is well-enough to develop new method to ease parking positions and give flexibility to the slot allocation system. In the previous study, advantages and disadvantages of this proposal are given and discussed [Çınar and Demirel, 2017].

Some of the advantages are;

- ACTOT provides flexible slot system to regulate traffic flow profitably.
- It will be possible to make some extra flights from the departure and issued airports as chain reaction.
- It will ease the calculation of passenger capacity for future periods as the year 2035 as increasing the capacity of airports.

Some of the disadvantages are;

- If offers will not be accepted totally, only some extra flights can be realized.
- The passengers have to come to the gates before 1 hour 45 minutes for domestic and 2 hours for foreign flights.
- To get ACTOT more attractive, the cost of ACTOT to the users can be get discount.

Theoretical and basic approach to application of new slot allocation procedure is good to use it for real-time. Besides the advantages of this process, there are some disadvantages that has to be overcome by executives.

In this study, it is important to keep ideas about this process to apply it to an airport in real-time. This study goes to another goals now as method to choose which aircraft operators will benefit it in a day by using mathematical model and determine the proper time limits to use new process. A follow-up of this study will be a research project to investigate the applicability to the real-time events in some European airports which are issued by slot allocation process.

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