1.1 Glossary of terms

Term	Definition	Source of the definition
Baseline delay, Baseline Time	Represents the allocated delay to each flight in a constrained situation if no UDPP. It is used as a baseline of the UDPP equity and can be used to benchmark the UDPP concept to identify the concepts' benefits.	
Capacity Constrained Situation (CCS)	A period of time in which the Capacity of an ATFM element (Airspace, Arrival Runway, Departure Runway …) is reduced. It defines the new capacity constraint due to this condition. In most of the case, this CCS will generate a capacity problem (Hotspot …) to be managed by Airport/DCB/NM.	
Demand Capacity Balancing (DCB)	Where used in this OSED to convey a role in the UDPP process, the term 'DCB' is intended to be the aggregate group including DCB, Local DCB, Airport, and Network Manager.	
FDR Fleet Delay Reordering	The feature by which using its own allocated slots, an AU can rearrange its fleet, by giving priority values.	
Hotspot	Term used by Network DCB to specify a safety critical area of interest, which generally has a demand that exceeds the available capacity. The Hotspot specifies that the situation has to be managed to decrease the overload. This hotspot could be resolved through delegation to the AUs and triggering UDPP.	
Knock-on delay or Reactionary delay	A side effect on subsequent flights due to delay given to an initial flight(s). The initial delays can be caused by capacity constraints, ATC/Network constraints, airport constraints, but also due to airline constraints (crew, passengers …). AU reactionary delay take into account all the AU fleet of the day to decrease the impact of the original delay, which is completely different from the Airport reactionary delay who take into account only the impact on the	

	local Airport platform.	
Margin of Manoeuvre	For an AU, it is the maximum delay a flight can take before incurring significant cost (disruption on the cost curve according to delay). It is anticipated that the "significant cost" can be defined differently by each AU, but for the purposes of this example, the cost represents a "spike" that is due to factors such as crew or pilot time-out constraints, or a large number of passengers who miss a connection, curfew, etc. Each time one of the factors is met; another spike in cost is incurred, which represents the end of another Margin of Manoeuvre for the AU.	
Prioritisation	Actions made by the AUs (using the UDPP features SFP, FDR, Slot Swap, Margins) according to the importance of their flights impacted by a Hotspot, based on their business needs.	
Protection/Protect a flight	UDPP Protection is part of the UDPP prioritisation. It is the highest priority given to a flight pushing its operation as closed as possible to the planned off block time. To do this, UDPP applies the SFP algorithm for this flight.	
Ration-By-Effort	The principle by which AUs first have to allocate additional delay to one or more of their flights in order to receive less delay (through protection or prioritisation) on one or more of their flights. This notion is used specially for SFP implementation.	
Scenario	An operational situation, in which, use cases are executed.	
SFP Selective Flight Protection	The feature by which an AU can obtain a desired delay for a flight, even if no ATC slot is available / has been allocated to the AU in question..	
Suspension	ATFM suspension (FLS) is an ETFMS message sent, suspending a flight, which thereafter should not get take-off clearance.	
"Time not After", "Time not Before"	It is the time components of the Margin of Manoeuvre. The feature by which allows a time window to be allocated by an AU to its	

	own flights, as a constraint. This is in order to rearrange the AU sequence.	
UDPP Suspension/Suspend a flight	UDPP Suspension is part of the UDPP prioritisation. It is the lowest priority given to a flight pushing its operation at the end of the problem managed by UDPP. It is not an ATFM suspension, i.e.: an FLS message.	
UDPP Cut-off Time, UDPP Measure Closed time (to AUs modification)	Absolute time defined when the "UDPP Measure" is initiated and specify until when AUs can set priorities/Margins on their flights. Over this time, the last prioritisation given by AUs on their flights are taken as "final UDPP prioritisation" to elaborate final UDPP solution. This time is used only if a flight is not become pre-allocated before: when flights are or become "airborne" (20 to 30 mn before Off-Block or flight considered as out of current regulation rules: coming from out of ECAC area, military flights …). Finaly this UDPP Measure Closed time is used generally for short haul flights with a short flight duration.	
UDPP measure	Term used in this document to trigger the use of UDPP. This can be in a CCS or in 'nominal' situations where demand exceeds capacity for a given period. An Airport/DCB/NM action must be taken to mitigate the situation. Originally, the overloaded situation (called sometime hotspot) does not necessarily contain all the impacted flights relative to the imbalanced situation (because it is not calculated at the beginning). The constraint declaration (CCS) is used to calculate all the impacted flight (all flights having delay) according to the Capacity constraints in a CASA like way (FPFS). Nevertheless, the UDPP measure can be set to a larger time window of even on a window without declared CCS, to allow AU to reorganize flights if needed. Up to the resource owner (e.g. Airport, DCB Network) to allow this delegation, called UDPP measure, in	

	collaboration with AUs.	
	The UDPP measure can also replace a Regulation measure.	
	UDPP generates the same delay than CASA on each flights if no AU input. The total delay of a regulation and a UDPP measure is the same. In a way, a UDPP measure is a regulation where AU can give priority on flights. The mitigation is given by priority from AU, the basis is the delay given by the CASA like part of the UDPP measure.	
	UDPP measure is not only the mitigation part but also the regulation part to avoid overload.	
UDPP Measure freeze input list time	Absolute time when the "UDPP Measure" is closed to new flight insertion in the UDPP Measure (new flight plan). UDPP Measure flights list becomes fixed. If new flights plan are declared, there are put at the end of the "UDPP Measure". NB: This time normally must be relative to moving time according to flights arriving time in UDPP Measure and not to the "UDPP Measure" starting time. (this must be updated in Wave 2) (ex: 2 hours before the flight arriving in UDPP measure).	
UDPP Priority value	A value given by the Airspace user on a flight (or a specified default value) used by the UDPP function to reorder the flights in the constraint. Values can be: P for Protect, S for suspend, B for keep baseline, or a number from 1 (highest priority) to 999 (lowest priority).	

1.2 List of Acronyms

Acronym	Definition
4D	Four Dimensional
AFUA	Advanced Flexible Use of Airspace
AMAN	Arrival Manager
ANSP	Air Navigation Service Provider

AOC	Airline Operations Centre
AOP	Airport Operational Plan
APOC	Airport Operations Centre
APT	Airport
ATC	Air Traffic Control
ATCO	Air Traffic Controller
ATFCM	Air Traffic Flow and Capacity Management
ATFM	Air Traffic Flow Management
ATM	Air Traffic Management
AU	Airspace User
BDT	Business Development Trajectory
CASA	Computer-Assisted Slot Allocation (Network Manager slot allocation for regulations)
CCS	Capacity Constrained Situation
CDM	Collaborative Decision Making
CFMU	Central Flow Management Unit
CI	Confidence Index
CNS	Communication Navigation and Surveillance
CONOPS	Concept of Operations
CR	Change Request
CTOT	Calculated Take-Off Time
D0	Day 'zero', Day of Operation
D-1	Day 'zero minus one', Day before Operation
DCB	Demand Capacity Balancing
dDCB	Dynamic Demand Capacity Balancing
DFlex	Departure Flexibility
DMAN	Departure Manager
DOD	Detailed Operational Description
EATMA	European ATM Architecture
E-ATMS	European Air Traffic Management System
EIBT	Estimated In Block Time
EOBT	Estimated Off Block Time
E-OCVM	European Operational Concept Validation Methodology
EXE	Exercise

F2F	Face-to-Face
FAB	Functional Airspace Block
FCL	Flexible Credits for Low Volume Users in Constraints (LVUCs)
FDA	Fleet Delay Apportionment
FDR	Fleet Delay Reordering
FIBT	Forecasted In Block Time
FIXM	Flight Information Exchange Model
FMP	Flow Management Position
FMS	Flight Management System
FOBT	Forecasted Off Block Time
FOC	Flight Operations Centre
FSFS / FPFS	First Scheduled First Served / First Planned First Served
HPAR	Human Performance Assessment Report
HSPT	Hot Spot
IBT	In-Block Time
ID	Identifier
INTEROP	Interoperability Requirements
IRS	Interface Requirements Specification
KPA	Key Performance Area
KPI	Key Performance Indicator
LVUC	Low Volume Users in Constraints
MPC	Most Penalising Constraint
MTTT	Minimum Turn-round Time
NEVAC	Network Capacity Evaluation Tool
NM	Network Manager
NMF	Network Manager Function
NOP	Network Operational Plan
OBJ	Objective
OBT	Off-Block Time
OCD	Operational Concept Description
OFA	Operational Focus Areas
OI	Operational Improvement
OPAR	Operational Performance Assessment Report
OSED	Operational Service and Environment Definition

PAR	Performance Assessment Report
PDS	Pre-Departure Sequence
PIRM	Programme Information Reference Model
QoS	Quality of Service
RBE	Ration-By-Effort
RBT	Reference Business Trajectory
RMAN	Runways Manager (first Airport process to organise departure)
RTS	Real-Time Simulation
SAC	Safety Criteria
SAR	Safety Assessment Report
SBT	Shared Business Trajectory
SCN	Scenario
SecAR	Security Assessment Report
SESAR	Single European Sky ATM Research, usually in reference to the European ATM Master Plan
SESAR Programme	The programme that defines the Research and Development activities and Projects for the SJU.
SFP	Selective Flight Protection
SIBT	Scheduled In Block Time (initial Airline schedule)
SJU	SESAR Joint Undertaking (Agency of the European Commission)
SJU Work Programme	The programme that addresses all activities of the SESAR Joint Undertaking Agency.
SME	Subject Matter Expert
SMT	Shared Mission Trajectory
SOBT	Scheduled Off Block Time (initial Airline schedule)
SPR	Safety and Performance Requirements
STAM	Short-Term ATFCM Measures
SUT	System Under Test
SWIM	System-Wide Information Management
TAD	Technical Architecture Description
TBD	To Be Determined
TMA	Terminal Manoeuvring Area
TS	Technical Specification
TSAT	Target Start-Up Approval Time
TTOT	Target Take-Off Time

TW	Target Window
UC	Use Case
UDPP	User Driven Prioritisation Process
UIBT	User In Block Time (prioritisation given by User)
UOBT	User Off Block Time (prioritisation given by User)
VALP	Validation Plan
VALR	Validation Report
VALS	Validation Strategy
V-FOC	Virtual Flight Operation Centre (FOC)
VP	Verification Plan
VR	Verification Report
VS	Verification Strategy
WOC	Wing Operation Centre

Table 1: List of acronyms

2 Operational Service and Environment Definition

Introduction of the UDPP features.

The UDPP feature can be used, by each AU that has more than one planned flight to enter into the congested period, when a UDDP measure is published.

The common aim of the UDDP algorithm is that, regardless of any actions performed by the AUs, the equity aspect is maintained.

The UDPP Prioritization must cover all the possible needs for an AU to rearrange the list of their flights. To enable broad usage of UDPP features, a number of parameters have been defined and are described in the following chapters.

UDPP features are originally based on the extension of the Slot Swap capability validated in SESAR1 Step 1, which is currently under deployment.

UDPP concept is based on three features:

- **FDR**: a prioritisation feature only based on the generalisation of the slot swap extension

- **SFP**: a specific prioritisation feature to force flight times into a time window even if there is no AU slot available for it.

- **Margins**: a feature to manage time windows associated to each flight.

Equity in UDPP

The notion of equity is fully integrated in the UDPP concept. All AUs claim to have an equitable solution to the problem of delay.

Today the FPFS method is widely accepted by AU to be fair and equitable as it preserves the original sequence of flights. In ATFM operations it is accepted as it minimizes the total delay by using available resources at 100% of the declared capacity

Equity in UDPP is implemented in a way that one AU's prioritisation does not negatively affect another AU.

To ensure equity, each AU's total delay shall remain the same, if no flight is suspended (explained in).

Equity in UDPP is managed and measured by two criteria:

- by comparing, the sum of the baseline delay obtained by the equitable algorithm (FPFS) on the AU flights (defined as an initial ATFM delay) with the result of the UDPP algorithm,

- and by the fact that whatever the time position in the sequence the cumulative delay of the solution is always equal or greater than the cumulative delay of the baseline delay for the AU (issue from the CASA like algorithm: FPFS). In other words, the AU cannot take a slot

if it does not give one at or before the slot they want to take. This is especially important for SFP to manage Protected flights.

o **UDPP FDR feature**

The FDR feature is based on enhanced slot swapping validated in SESAR 1.

According to the slot assigned to each flight of an AU, FDR gives the possibility for the AU to assign its own list of flights to each slot given by the FPFS slot list. In particular, the flight the AU is interested to decrease the impact of the delay on its fleet can be "swapped" with another flight from its fleet. For this, the AU can put a priority value on each flight to be reordered.

FDR priority values can be set to:

- A priority number from 1 (highest priority) to 999 (lowest priority) to give flights a relative ranking number (up to the AU to choose the range of priority to apply. This range can be decided according to the way and the AU internal tool used to manage the UDPP measure. E.g.: this priority value could be a ranking value over all the AU flights within the UDPP measure).

- "L" Lowest priority flight of the AU: specifies the AU's lowest priority flight(s) whatever the value given to its other flights (could be seen as the 1000 priority value). The flight will take the last slot of the AU.

- "B" Baseline priority: specifies to keep the baseline delay of the flight as the current target delay.

- "S" to suspend a flight: specifies that the flight will no longer be in the middle of the UDPP measure, up to the AU to take a decision concerning this flight (cancellation, diversion, rerouting …). It becomes the least important flights of the UDPP measure, and the flight will be allocated after the last not suspended flights of the UDPP measure.

To avoid giving priorities to all the flights in the UDPP measure, the AU can set a default priority value to be taken if no priority is given to a flight.
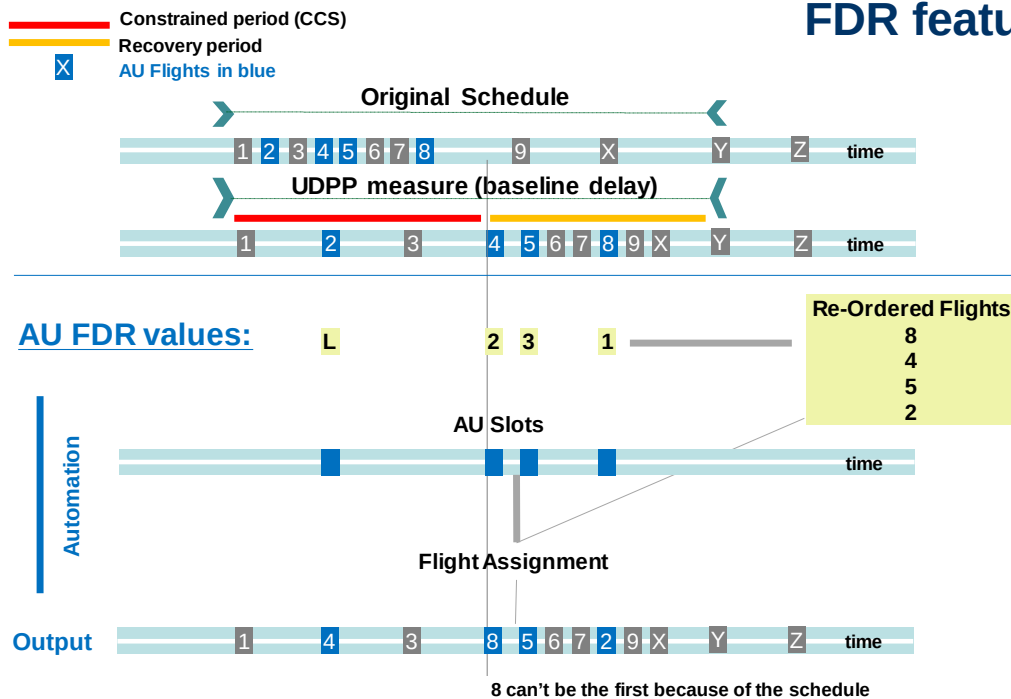Generally, two priority values can be considered to have default values:
- The "B" value is given as an default value if the AU wants to limit the number of changes of flights, in this case the reordering is apply only on flights with a priority value.
- The value 5 is given as a default value, if the AU has decided to use priority from 1 to 9 only (or 50 for using priority from 1 to 99). This default value allows flights with no priority to be part of the reordering as middle priority flight.
- Other values are allowed according to each AU's specific way of managing priorities on flights.

Note that if no suspended priority value is used ("S"), because FDR is based on slot swapping, there is no impact on other flights from other AUs and the sum of delay for each AU is the same without or with priority values.

The specific suspended priority value allows the AU to take advantage of this action to create a better situation for him, for its other flights. At the same time, because a suspended flight is allocated to an available slot after the last flight of the UDPP measure, it can be considered that the UDPP Measure is decreased and all of the AUs will benefit from this action.

FDR feature

Constrained period (CCS)
Recovery period
X **AU Flights in blue**

Original Schedule
1 2 3 4 5 6 7 8   9   X   Y   Z   time

UDPP measure (baseline delay)
1   2   3   4 5 6 7 8 9 X   Y   Z   time

AU FDR values:
L   2 3   1

Re-Ordered Flights
8
4
5
2

Automation

AU Slots
time

Flight Assignment

Output   1   4   3   8 5 6 7 2 9 X   Y   Z   time

8 can't be the first because of the schedule

Equity : Neutral impact for all flights from other AUs

1.1.1.1.1 UDPP SFP feature

The SFP feature is the specific priority value "P" (for protect) to give to the AU the possibility to protect the schedule of a flight (Pflight) even if there is no direct current slot allocated to the AU.

To do so the AU must have, a minimum of one slot before the original schedule of the protected flight (within a window: called the Pobjective) to not affect other AUs negatively from its action.

If an AU places a P on a flight, the UDPP algorithm, first tried to find an AU slot within the Pobjective time window. If no slot is available at the Pobjective time window, the algorithm finds the first available slot earlier then the flight's schedule. When a slot is found, the AU's flight with this current slot is swapped to in the actual slot of the Pflight and the Pflight is allocated to its new slot closer to the original Schedule.

Note that:

- If a slot is available within the Pobjective, the solution is identical to a flight with a FDR value of 1 (or 0, ensuring that it's a higher than any 'priority 1 already assigned) .

- If no slot is available within the Pobjective, no negative impact is generated to the other AUs but positive impact may be experienced.
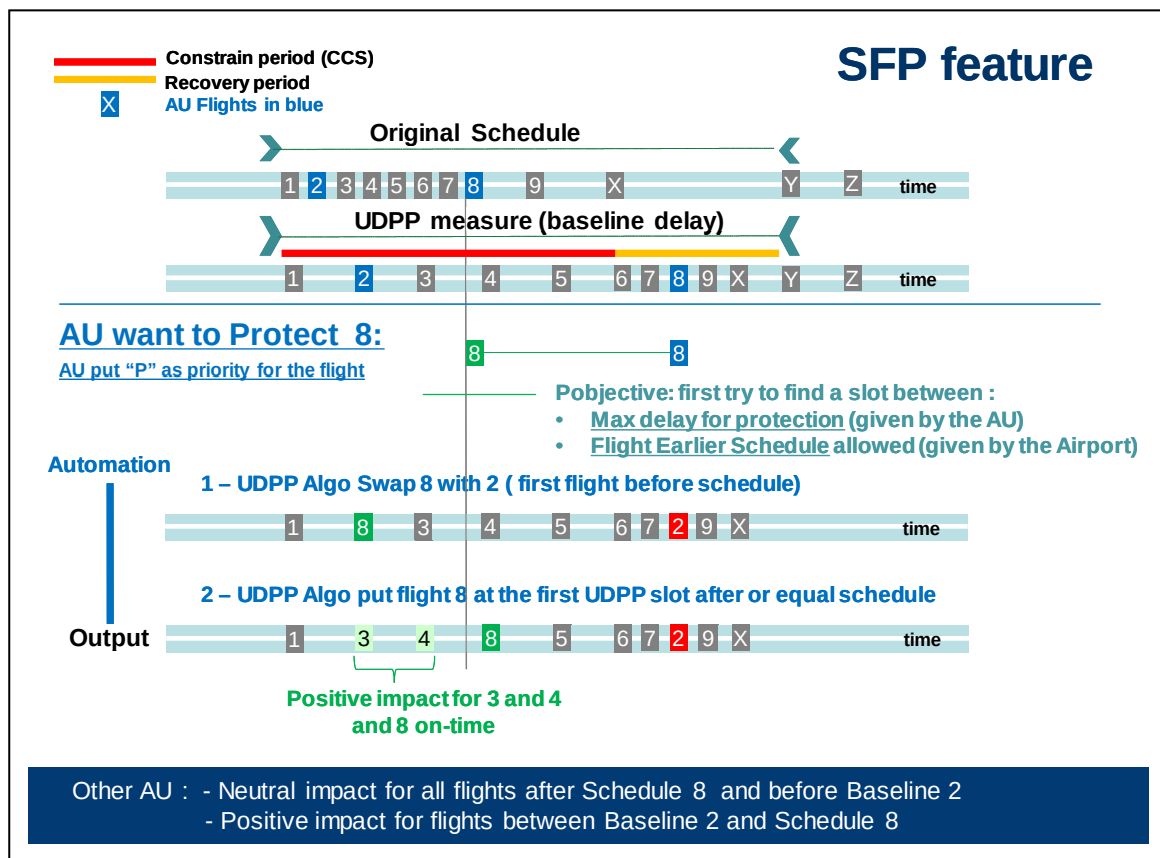
Figure 1: example of SFP

The Pobjective of a Pflight is given by two parameters:

- The MaxDelayProtection: this AU parameter gives the maximum delay acceptable for a Pflight according to its schedule time: (e.g. 5mn or 10mn). This parameter, defined by the AU, and applicable to all its Pflights, can be changed dynamically to adjust AU objectives on Pflights.

- The HotspotFlightEarlierSchedule: this airport parameter (common to all AUs) gives the maximum early departure or arrival delay buffer allowed by the airport to manage flights. (e.g. 5mn = 5minutes before schedule is allowed)

Note that, if margins are specified for a Pflight, Margins are taken in replacement of these two Pobjective parameters (above) if they are compatible (see 1.1.1.1.2).

1.1.1.1.2 UDPP Margins feature

Margins on flights provide the AU with the possibility to express time constraints on certain flights with time values, as per below. Currently, a specific algorithm has been developed named "Margin" to allow the possibility of such feature.

Margins on flights can be given by two values:

- "Time not After": specifies a time by which the flight is requested not to be later than the value indicated.

- "Time not Before": specifies a time by which the flight is requested not to be earlier than the value indicated.

The objective of the algorithm is to rearrange flights automatically according to these time constraints using the AU's own slots (similar to FDR, but not based on priority values, but based on time values).

Within the 'Margin' algorithm, a priority value can be allocated on flights where the margin has been set. This priority value can then be used in tandem with the time values indicated in Margins and is used when not all the margin values can be met, in this case the highest priority Margin (Prio = 1) is matched first etc…. Another way to see this priority value is to allow it according to the importance of the cost or lack of resource generated by going over this margin.

For example a flight with a "Time not After" with a priority=1 will be managed first, and then, have its 'Time not After" objective realized. Then a flight with a "Time not After" with priority=6 will be managed after and its 'Time not After" objective will not be necessarily realized if the available AU slot cannot give it.

Providing Margins is not mandatory on flights, if no Margin value is given on a flight, the flight is managed as a FDR flights (using only the priority value or the default one if priority is also not given for this flight).

1.1.1.1.3 Margins on Protected flights

The protection of a flight does not necessarily mean that the flight will be on time (even with a Pobjective given by a small window representing the On-time Objective).

The AU can, if required, protect a flight within a time window by defining Margins.

If margins are defined for a specific Pflight, the Margins replace the time value of the Pobjective:

- If a "Time Not After" is given to a protected flight, this time replaces the upper Pobjective time (normally set by Schedule + MaxDelayProtection).

- If a "Time Not Before" is given to a protected flight, this time replaces the lower Pobjective time (normally set by Schedule – HotspotFlightEarlierSchedule).

Only one of the two Margins could be given.

The algorithm checks that:

- The Time Not After could not be earlier then the schedule.

- The Time Not Before could not be earlier then the Schedule - HotspotFlightEarlierSchedule.

- The Time Not After >= Time Not Before

1.1.1.1.4 FDR, SFP and Margin are mixed in the same priority value approach

All the UDPP features are managed through a single algorithm, allowing the AU to use a mix of the different possibilities to organize his fleet.

The algorithm manages the flights in the following order:

1. Manage Protected flights (flight with a "P" as priority value)
2. Manage Margin flights (flight with a "time not after" value without a "P" as priority)
3. Manage default Baseline flights (flight with No Margins values, no priority value, and when the defaults priority is "B")

4. Manage flights with priority value (flights with a priority value 1 to 999 or "L" (= to 1000) with no Time not after)
5. Manage Suspended flights (flights with a "S" as priority value)

1. AU inputs: different ways of thinking

AUs have a number of different options when mitigating the impact of delay on their fleet.

No specific features is mandatory, the objective is to allow AUs a large possibility to interact with the UDPP algorithm according to their own capability, configuration, model and tools.

Whilst the use of the different UDPP techniques / solutions is not mandatory, the objective is to allow AUs the possibility to interact with the UDPP algorithm through the use of these techniques in order to reduce the impact of delay.

Some example are defined here.

Usage of default value: the default value is apply when no priority is given to a flight.

This default value can be set by AU to "B": in this case, only flights with a priority value are part of the re-ordering. This way of setting priorities limits the number of changes for the AU flights, but also limits the number of possibilities to find a solution.

If the default value is set to a number (e.g. 5), all flights in the UDPP measure are rearranged and the delay is distributed over all the AU flights.

N.B.: "B" can be specifically set to a flight if the AU wants to exclude the flight from the reordering: keep Baseline as a solution.

Questo è il dubbio B In seguito (mange Nflights) non viene esplicitato, pertanto credo che vengano esclusi anche lì. NB: la nota ha senso una volta letto l'algoritmo (dopo)

Usage of the "Protect" priority:

Generally, "P" is used for important flights to allow them to be "on time" even if no slot is available for the AU. This can cause extra overall delay by pushing lowest priority flights later in the sequence. To be noted that starting by using priority 1 for this flight could be helpful for rearranging the sequence without impacting the overall delay.

On the other hand, using 'P' with margins, could increase the possibility of finding a solution.

Usage of Suspend "S" or Lowest "L" priority

"S" is foreseen to be used only when the impact of pushing a flight completely outside of the UDPP measure is beneficial to the AU.

Otherwise, use "L" for lowest priority flights. The flights will be assigned in the last slot of the AU.

UDPP features timeline

UDPP can be considered a consolidation of different processes and features: FDR, SFP, Margins, but also Extended Slot Swap developed in SESAR1 Step1 environment.

The different features can be used depending on the magnitude, and type, of problem that the AU is trying to mitigate.

2 Definitions

Slot Definition in UDPP:
Currently in UDPP, we use the term Slot because UDPP manages flights like a NM regulation, except that, instead of using CASA to give the time solution, the flight reordering in managed by the UDPP server (the entity who regroup all the UDPP functions) and a new UDPP time is given relative to the priorities given by AUs.
Today, UDPP Slots define only a time without a time window around like normal CASA Slot.
Future investigation will be done to add to this UDPP time an appropriate time Window. This investigation will be done in wave 2 when UDPP functionalities will be integrated in the NM system.

Baseline time (Baseline Slots List), Baseline delay:
Time assigned to a flight by the CASA-like algorithm (First Schedule First Planned). This time is calculated by the UDPP server according to the Capacity definition on the Resource to manage (e.g. Runway) and the planned flights on it. Values are saved in the Baseline Slot List.
Baseline Delay is [BaselineTime – Flight Reference time= generally ScheduleTime)

Flight Reference time:
Currently the Reference time is the schedule time of the flight, but according to Airport Runways management style, sometime the flight Schedule is ignored and only current situation is managed.
In this kind of Airport, the Reference time could be the current flight time when "UDPP Measure" is created.
In this document, we can use Schedule time instead of Reference time because it is the standard definition of the Reference time.

AU Intermediate Local Slots List:
Intermediate Slot list generated by the Ranking Method, because the Baseline Slot List can be updated by the management of the Protected flights (Pflights)

AU Local Slots List:
AU can manage only its own slot list. The AU Local Slots List is the time given on each AU flights after AU prioritisation method (selected by AU) by conversion of AU input priority and settings, implementing Equity, using only flights of the AU. This Local Slots list has to be merge with all the other AUs flights to have the final UDPP solution: the UDPP Slot list.

UDPP Slots List:
Final result of UDPP, merging all AU Local Slot Lists.

Airborne flights:
Used to specify flights not available for prioritisation: keep the current time as target UDPP Slot.

Terminated flights:

Flight already landed (no way to change anything in term of prioritisation), excluded from lists.

CCS (Capacity Constraint Situation):
Definition of the constraints on the resource, (e.g.; the runway capacity constraints: could be a stair given by more than one consecutive constraint…)

UDPP Measure:
The set of flights concerned by a Capacity Constraint Situation (delay is given on each flight).

HotspotFlightEarlierSchedule:
Early time departure or time arrival authorised by the Airport and accepted by the AUs, to be used by UDPP algorithms. This value is an authorized negative delay given in minutes relative to the Flight Reference time (Schedule). This value also implies that AU must be ready to accept this earlier time.

Hotspot time for freezing Input flight list (late filler):
Time when the "UDPP Measure" is closed to flights insertion, AU flights list becomes fixed; if any, new flights are put at the end of the "UDPP Measure". NB: This time normally must be relative to flights and not to "UDPP Measure" (through a moving window).

Hotspot Closed time (to AUs modification):
Absolute time relative to the "UDPP Measure" until AUs can set priorities on their flights, over this time, the last priorities given by AUs to their flights are taken as "UDPP Measure" solution.

Pflight:
Flight with "P" priority: Protected Priority (highest priority for the AU).

Psolution:
It's the local time solution of a Pflight. This time could be slightly changed when merging all AUs flights or by the optimisation (merge function)

Sflight:
Flight with "S" priority: Suspended Priority (lowest priority of the "UDPP Measure": flight(s) candidate(s) for Cancellation).

Lflight;
Flight with "L" priority: Lowest Priority (lowest priority of all flights of the Airline in the "UDPP Measure"). if several Lflights are set, Lflights are managed in their baseline time order.

Bflight:
"Baseline" priority: keep baseline delay as target time for UDPP algorithms (this time could be earlier according to resource optimisation). Two kind of Bflight are possible:
Explicit Bflight: a B priority value is given for this specific flight by the AU

Default Bflight: no specific priority is given for this flight, but a B priority is given as the Default priority value.

3 General UDPP algorithm view

The UDPP Algorithms are composed by 3 consecutive steps:

1) The Baseline Slot Allocation using Resource constraint definition (CCS, all flights concerned …) to generate Baseline Slot Allocation (CASA-like Algorithm).

2) The local AU flights management uses AU input flight priorities (priorities and/ or margins) and settings, implementing Equity, to generate a new AU local Slot List for each AU flights inside the "UDPP Measure" (based only on the local AU flights). Basically convert AU Prioritization in Time to be merge with all AUs flights.

3) The merge of all AUs Flights: In the "UDPP Measure", each AU can send its priorities independently one from each other. To generate the What-If or Submit sequence adapted to the specificity and dynamicity of the CCS, the merge function integrates all AU local prioritisation given at the different time.

To be noted that when one AU send its prioritisation, all AU flights in the UDPP Measure are recalculated according to the last current status of all flights integrating last flights prioritisation, to have always an up-to-date solution for all flights.

This algorithm structure organisation has been elaborated to manage Protected flights and Suspended flights that could generate possible changes of the Initial Slot List produced by the Baseline Slot Allocation.
According to Holes created in the Baseline Slot list by the Suspended flights and the possible re-arrangement of the Slot time due to Protected flights, a final recalculation of an Optimum UDPP slot list is mandatory to avoid loss of runway throughput.

3.1 Parameters Specific to each AU (defined by AU and can be dynamically changed)

- Default Priority Value: it is the value taken as default Priority, when no priority is specified for an AU flight.

- Max delay for Protection (MaxDelayProtection):
  The "MaxDelayProtection" parameter specifies the maximum delay (based on Reference Time) to manage Protected flights.
  This parameter is used for the *Time Window For Protection*: Pobjective (see next parameters).

[Rule_1]   Time Window for Protection (called Pobjective):
  the default Time Window for Protection is defined by [Reference Time – HotspotFlightEarlierSchedule, Reference Time +_MaxDelayProtection].

[Rule_2]   If a Margin value is specified for this flight, The Margins values "Time Not Before" and/or "Time Not After", overwrite the default Pobjective

[Rule_3] A Protected flight has first to find a solution inside its Time Window. In this case, there is no impact on overall delay of the Airline because an AU slot is used. If more than one flight is in this time window (Pobjective), the flight with the later time in the window is taken to limit the impact on the others AU flights.

- Local Ranking model: AU can dynamically apply a ranking model: Priorities only (1) or Priority and Margins (2) to manage their flights with UDPP.

3.2 The CASA-like time calculation on constrained resources

Input:
All flights that could concern the "UDPP Measure" extracted from NM according to the resource to manage.

The CCS who defines the minimum size of the "UDPP Measure" (the "UDPP Measure" could not start after the beginning of the CCS and could not stop before the end of the CCS).

According to the traffic on the CCS, the "UDPP Measure" could start before the CCS if residual delay before creating the CCS, and end after the CCS to manage the recovery period.

If the CCS impact and the CCS itself is disjunctive (no times in common: this could exist for a CCS with a rate of 0):

- starting time of "UDPP Measure" is the earliest time between the 2 starting times (CCS and CCS impact)
- ending time of "UDPP Measure" is the latest time of the 2 ending times (CCS and CCS impact)
- NB: this rule also cover the previous rule but the first rule stay defined to clarify the definition.
- Side effect on that:
    1. We could have some empty slots in the baseline sequence that can be used by AUs when making prioritisation. In this case, we can see differences between total delay from baseline time and total delay of What-If (less total delay with UDPP).

Output:
- Baseline Slot List (All Flights in the "UDPP Measure"). Currently the size of the slot is not defined yet and used in UDPP. It will be studied later one.

Objective:
- This algorithm (CASA-like algorithm) generates the baseline delay on Schedule/ Reference Departure / Arrival Time or any constraint to manage flights affected by the Capacity Constraint Situation.

- This part of the UDPP server, creates the "UDPP Measure" with associated baseline delay relative to the reference time (baseline time) on each flight by allocating flight on resources (runway) according to their current capacity definition including the CCS characteristics.

Capacity Constraint Situation (CCS) example:
Normal Capa = 60 (flights/hours) --> minimum time between 2 flights = 1 minute.
From 6:00 to 7:59 Capacity = 30 --> minimum time of 2 minutes between 2 flights.
From 8:00 to 9:59 Capacity = 45 --> minimum time of 1 minute and 20 seconds between 2 flights.
Etc....
N.B. Pre-allocated flights (airborne flights, non ECAC flights, terminated flights …) are forced to their current time (like in CASA).

[Rule_4] Due to the CCS, All flights are allocated to a slot and have a baseline time. A "UDPP Measure" is automatically created by UDPP around the constraints, starting by the first flight with "a delay (delay different to 0)" and ending just before the first flight after the CCS starting with "0 delay", this includes the recovery period. The UDPP Measure can start before the beginning of the CCS due to existing delay not previously managed.
The "UDPP Measure" 'could be' manually adjusted by the owner of the resource, only by adjusting the CCS time starting and finishing because the CCS period is the minimum period of the "UDPP Measure". This period is always checked and published manually by the owner of the resource and become the "UDPP Measure".

"UDPP Measure" Dynamicity:
A time is given to freeze flights entering in the "UDPP Measure", called "Hotspot time for freezing Input flight list" (like in CASA - e.g. 2h before "UDPP Measure"). When the Freezing time is passed, no more flights can be added inside the "UDPP Measure" except if the is empty slots available, new flights are pushed at the end of the "UDPP Measure" and the "UDPP Measure" is extended. These new flights can be managed by the AU as the others, only the Baseline Slot Time is at the end of the "UDPP Measure". In this case, flights are not excluded from the AU priority management.
Before this freeze time, new fights can be added inside the "UDPP Measure" according to their Reference time (Schedule or Current)
The Content of the "UDPP Measure" is always updated when an AU send a flight prioritisation. This "UDPP Measure" must reflect the up-to-date status of all the flights and CCS especially when time run and some flight become pre-allocated.

UDPP global Delay Calculation for network KPI (to be developed later):
When UDPP delay is mitigated by Airlines, a new method to calculate Network delays must be issued to take into account the AUs wishes: flights with High priority must have less delay than flight with Low

priority. A new formula for delay calculation must be issued taking into consideration a ponderation factor due to AU prioritisation. AU prioritisation must be taken as a new demand from AUs face to the CCS problem.

NB: The "Baseline time" (baseline slot allocation) is relative to the flight reference time taken as initial condition (Schedule or Current time). According to the specificity of the different Airport, the UDPP can be specially tuned to cope with this specificity: the Reference time could be the Schedule time or the current value of the time when the "UDPP Measure" is created. In this case, the Baseline Slot list takes current situation as reference. The schedule time can still be used to specify the minimum time to be allowed to flights (with HotspotFlightEarlierSchedule subtracted if defined). But this possibility is not managed by NM ATFCM because the schedule is ignored.

3.3 The AU local flight management: local ranking models + time assignment

The ranking models are basically the 2 models of prioritisation used by UDPP: ("Priority only", "Priority and Margins) and a re-assignment of the flights on the available slots, but due to the management of the Protected flights and the Suspended flights, they are a bit more elaborated to adapt the solution to the AU needs.

Input:

- AU flights
- Baseline Slot List for the AU,
- Priority values (including flights margins if any) for each flight
- and the AU parameters (Default Priority Value and Max delay for Protection)

Output:
AU Local Slots List

Objective:
Convert AU Priority values to new time for AU flights according to parameters and equity.

The objective of this local part, specific to each AU, is to generate a new local time for each flight (AU Local Slot List) according to input given by the AU (priority values, margins values, ranking model) and equity rules. This is basically based on using allocated AU Baseline Slots (baseline time generated by the CASA-like Algorithm) to rearrange the flights in a more convenient and efficient sequence for the AU.
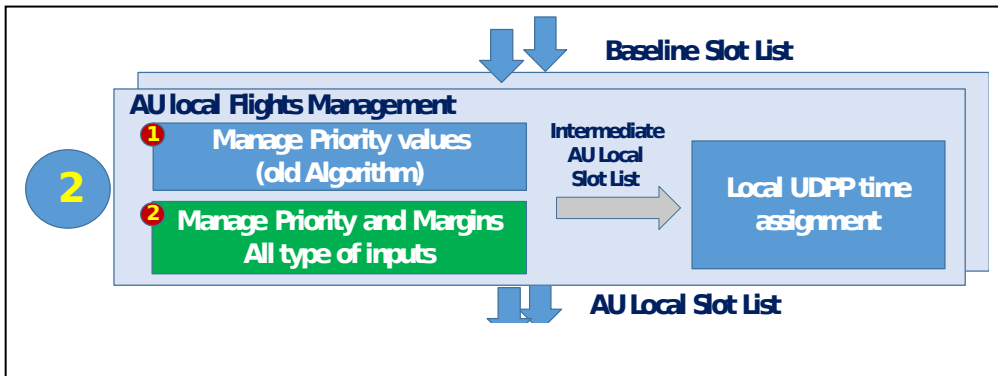
Figure 2: AU local flight management

The AU local flight management is split into 2 consecutive parts:

1. **The Local Ranking algorithm**: based on AU input priority values and/or input margins and parameters.

The objective of this part is to translate the Priority inputs values (made of integers, letters, margins) into an AU flight list sorted according to the need of the AU, and an intermediate AU Slot List (with times) possibly modified by the management of the Pflights.

2. **The Time Assignment** of flights on intermediate AU Local Slots (the local slot list times could be modified by the Pflight management.
   According to the type of Algorithm selected by the AU, when the AU calls the function What-If or Submit, the AU local flight management runs the selected Algorithm to manage its own flights.

   1. The "Priority only" ranking model: uses only the input priority values entered by the AU

   2. The "Priority and Margins" ranking model: uses the input priority values to manage flights but using also the input Margins as time target. This Algorithm type regroup all the possibility to manage flight in one model.

[Rule_5] Flights in AU Slots list containing flights with airborne and terminated status are excluded from the ranking methods but must be still visible for AU and UDPP functions.

3.3.1 The Local Ranking models

2.1.1.1 **The "Priority only" model**

To be noted that this "Priority only" algorithm is still defined in this document because it can be used as a Ranking model but it is replaced by the "Priority and Margins" model who merge all king of prioritisation. There is no difference between "Priority only" outputs and "Priority and Margins" outputs if no Margins are defined for flights.

The definition of this model is done on the "Priority and Margins" model chapter. The difference is that the management for the Margin flights is not done for "Priority only".

Figure 3: Ranking Model: Priority Only
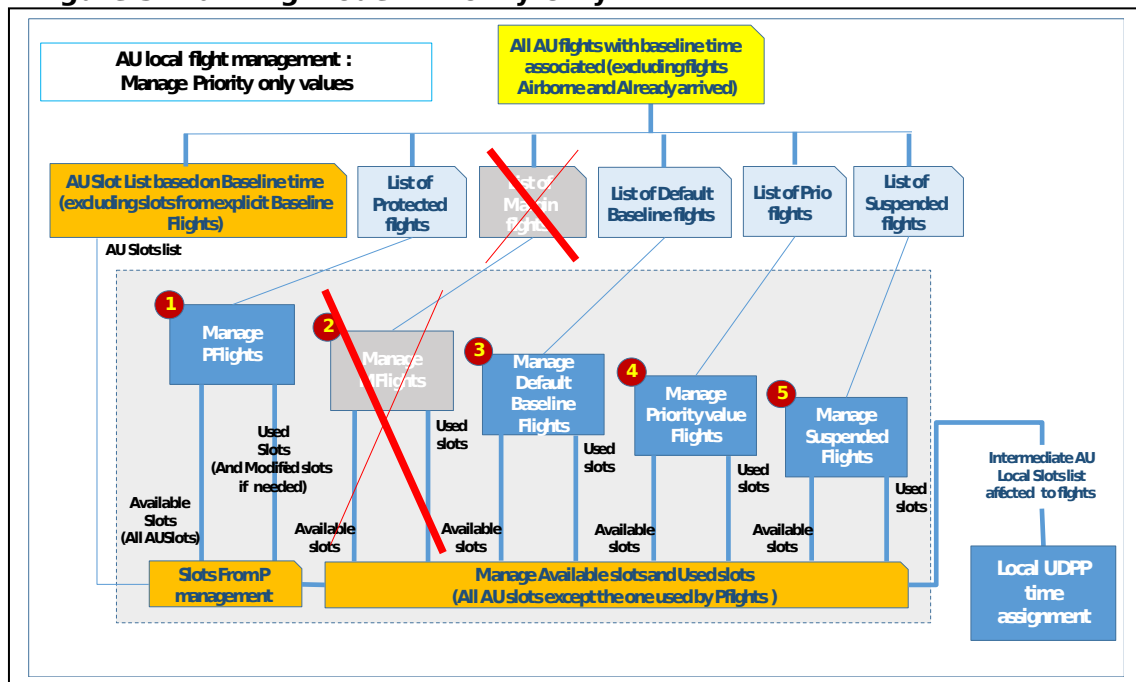
2.1.1.2 The "Priority and Margin" model

The '**Priority and Margin'** model of algorithm manage all type of priorities: SFP, FDR and Margins with or without a priority value.

UDPP priority values can be:

- "P" to Protect a flight: very important AU flight(s) (Pflight), to be as closed as possible of the Margins if defined or the Reference time if not (see 3.1)

- A priority number from 1 (highest priority) to 999 (lowest priority) (Nflight) to give flights a relative ranking number.

- "L" Lowest priority flight: to specify the AU lowest priority flight(s) (Lflight) whatever the value given to its other flights (could be seen as the priority value = 1000)

- "B" for Baseline: (Bflight) to keep Baseline delay of the flight as the target time.

- "S" to UDPP Suspend a flight (Sflight): this flight becomes the less important flight of the "UDPP Measure", it a candidate to avoid "UDPP Measure" or to be cancelled later on.

A Margin value can be given on flights:

- "Time Not After" (TNA) specify the latest time to be given to a flight
- "Time not Before" (TNB) specify the earliest time to be given to a flight

To be noted that, according to the current status of the flight and the clock, a dynamic value of TNB and TNA is calculated to drive the possible local slot allocation (see 2.1.1.3 Dynamic Management of Time Not Before and Time Not After).

A combination of Priority and Margin is possible and give a large amount of possibility to the AUs to give constraints to the UDPP algorithm to have a slot corresponding to the UDPP rules and AU constraints. This combination allows representing the cost/delay curve of a flight: Time Not After (TNA) is the time constraint not to exceed and the Priority is relative to the extra cost if exceed.

To implement this model, the Management of the different flights generates a list of flights to be given to the Local UDPP time assignment.

The local flight management for this algorithm is based on 5 steps organised in the following order:

1. the management of the Protected flights (Pflights), then
6. the management of the Margin flights (Mflights), then
7. the management of the default Baseline flights (dBflights), then
8. the management of priority flights (numbers and 'L') (Nflights), then
9. the management of the Suspended flights (Sflights).
   2.

The description of the Local AU flight management is graphically explained in the following figure.
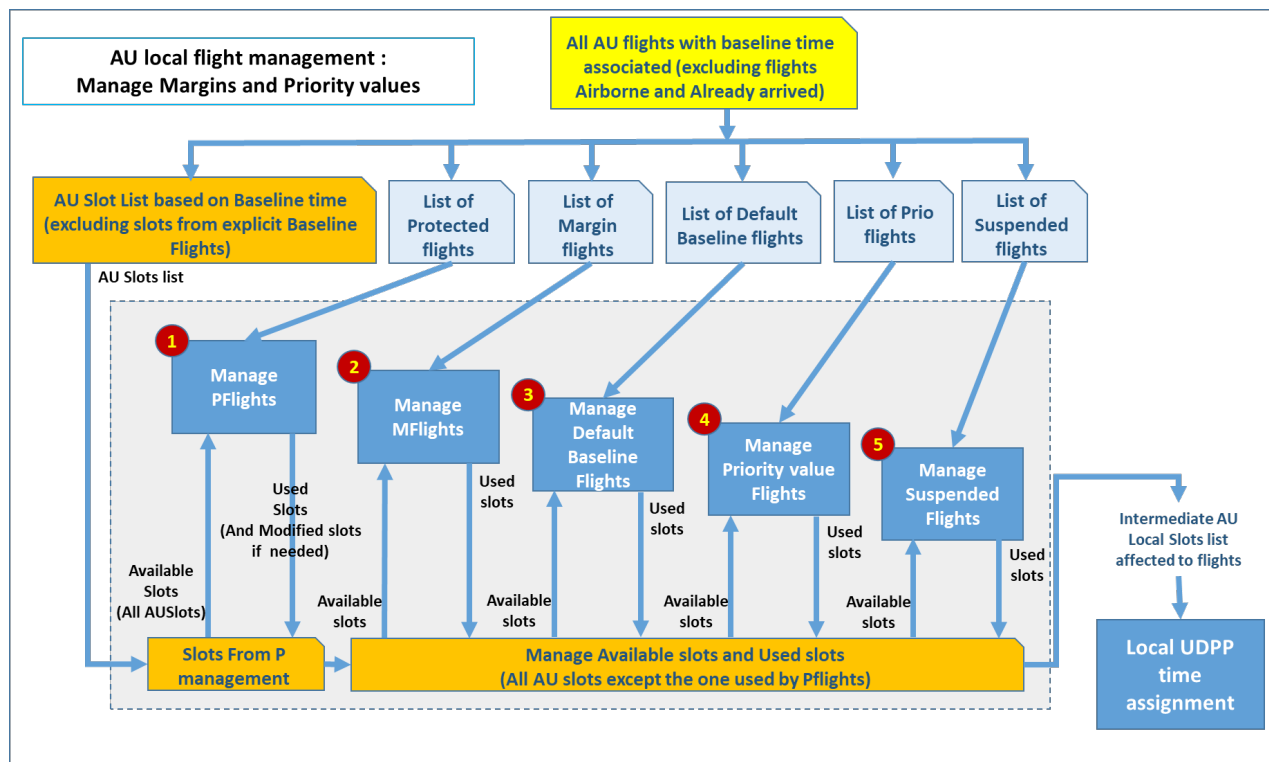
Figure 4: Local flight management: Priority and Margins

3.3.1.1.1 Step 1 - Manage Protected flights (Pflight) (with Margins or not)

The objective of this part is to assign a slot to the Protected flights using 'Time not After' and 'Time not Before' if defined for this Pflight.

A Pflight is defined by the fact that its priority is "P" with Margin or not.

[Rule_6]   The Pflights have a particular priority, which corresponds to the highest priority of the fleet "P".

[Rule_7]   To find a time for the Protected flights, the first objective is to find a local slot "close to their schedule" in the AU Baseline Slot List to fulfil the "Pobjective" (defined hereafter) for these flights.

[Rule_8]   The AU slots used to find a Pflight solution are All AU Local Slots, including default Bflights (refer to Default Priority Value parameter) but excluding AU Explicit Bflights as well as Airborne and Terminated flights.   Dubbio B: qui viene espressamente specificato di escludere i Bflights

[Rule_9]   Pobjective of a flight is given by 2 parameters or Margin if defined:

o The MaxDelayProtection: this AU parameter gives the maximum delay acceptable for a Pflight according to its schedule time: (e.g. 5mn or 10mn). This parameter, defined by the AU, can be changed dynamically to adjust AU objectives on Pflights.

o The HotspotFlightEarlierSchedule: this Airport parameter (common to all AUs) gives the maximum early departure / early arrival buffer subtracted to Schedule Time of all AU Pflights: (e.g. 5mn)

Pobjective: find a slot time inside the Time Window for Protection [Reference Time – HotspotFlightEarlierSchedule, Reference Time + MaxDelayProtection]

Protection Algorithm (for Pflights):

The Management of the Protected Flight algorithm is the first algorithm applied for the "Priority and Margins" algorithm model when the What-If or Submit button is pressed.

It's based on 2 steps:

[Rule_10]   Find an already defined AU Local Slot matching Pobjective (defined above), allocated to a AU flight with a priority lower than Pflight.
If found: the Psolution is the Slot of the flight found.

[Rule_11]   If no Pobjective solution is found:

a. Find the first AU slot before the Schedule of the Pflight with a priority different of P.
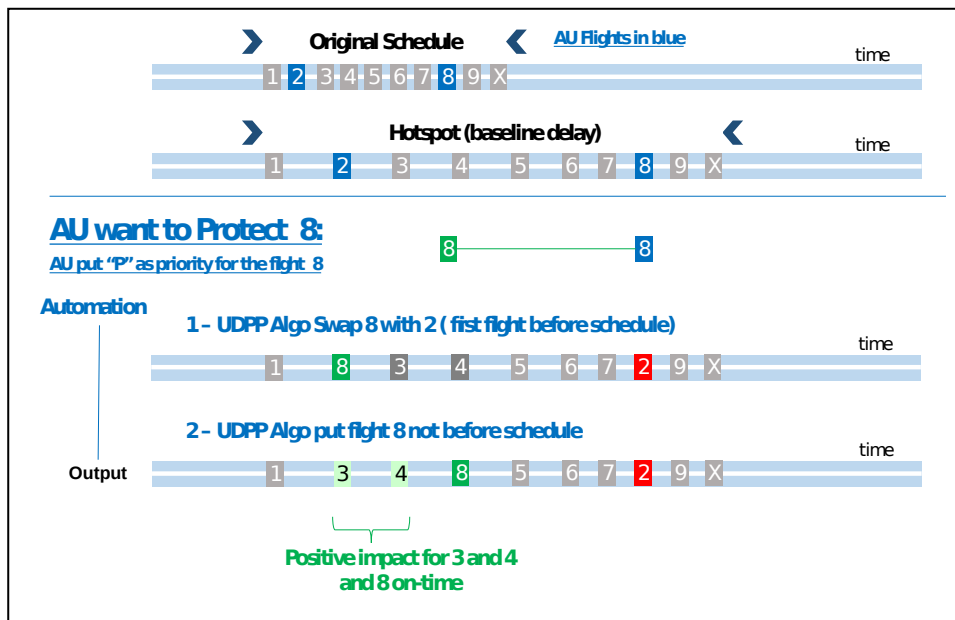
Figure 5: Pflight management example

Pflight has an earlier solution. This is clearly visible if many Pflights are defined.
This can be solved by rearranging the slots of the Pflights by sorting them by 'Time not After' which is part of the Pobjective (assuming that if no 'Time not After' is given the time value is : the Reference time + Max delay for protection).

NB: this Pflights Management can change the slot assigned to the AU if no Pobjective solution is found for a Pflight. This new slot list (with increase value of the sum of delay) is the one taken to manage the others flights.

3.3.1.1.2 Step 2 - Manage Margin flights

Margin flights are defined by the fact that there is for the flight, a **'Time not After' value** given but h AU and **its priority value is not P** (otherwise it's a Pflight). If no value is given on 'Time not After' field, it's not an Mflight, if a P is given on priority value, it's a Pflight whatever the content of the 'Time not After' field.

There is no default Margin for an Mflight. If there is no 'Time not After' value, the flight is **NOT** a Mflight and is manages according to its priority value or default priority value.

The Margin 'Time not After' and the Priority value are used to manage the Margin flights. If no priority is given, the defaults priority value is taken (defined by AU in the interface as defaults priority and also used to manage priority only flights). For Margin management, if the **defaults priority value** given is **Baseline, the priority assign to the Mflight** is considered **as lowest priority ('L')** . This because default B for a Mflight is declared less importance than a real priority value (it's considered that flight will have a cost less important to manage than others if delay go over its 'Time not After').

Dubbio B: qui viene espressamente specificato di NON includere i Bflights

The candidate Slot for the Margin flights can be found on all the available slot of the AU **except the one already assigned to the Pflights** and the one **with an explicit B value** (explicit Baseline priority value given on a flight).

The Margin flights are assigned to slots in the same order then their priority value and 'Time not After' value, using the 'Time not After' as time objective to be not over (use the latest time slot before being over the 'Time not After'). For flights with, same priority value, same time not after, the order must be as the baseline time. In other word, the list of Mflights is sorted by : 1) Priority values (including default one) then 2) if same priority by 'Time not After' then 3) if same priority and 'Time not After', the Baseline time.

If it's not possible to fulfil the Margin as define by the 'Time not After': first an earliest available slot must be assign to the Mflight, respecting the fact that the flight already assigned must not have a degraded slot (earlier slot but not later) which is given by the priority rule; an second a slot later if no possibility earlier.

In algorithm language:

Dubbio A:
Manage Time Solution, che nella tesi ho chiamato AssigneOr MoveEarlier non si capisce bene come funzioni (dopo c'è la definizione)

- Get all flights to be managed: Margin flights (All AU flights in the UDPP measure with 'Time Not After' value except Pflights, and explicit B flights).
- The assignment will be done on the list of available slots for the AU (to be share with Margin and not Margin flights) except the slot already used by the Pflights.
- Sort Margin flights by 'Priority' then 'Time not After', then 'Baseline time'
- On each Margin flights, call the **Function "Manage Time Solution"** to assign a slot to Margin flights (see function description after)

3.3.1.1.3 Step 3 - Manage the Default Baseline flights (dBflights)

The objective of this part is to assign a slot to the defaults baseline flights (dBflight).

Default Baseline flights are defined by the fact that 1) the default priority value is set to 'B', 2) and the flight has no priority value and no Margin.

The objective is to assign to these flights a slot closed to their Baseline time value.

The slot assignment of the baseline flight is done in the same way than the Margin flights, minimizing the degradation of the already assign flights (Margin flights).

The objective is to:

- Assign **default B flights** to the closest slot (not degrading Mflight slots) of their Baseline time. This is done by calling the **Function "Manage Time Solution"** exactly in the same way than Margin flights, but with target time = to the Baseline time of the flight (instead of the 'Time not After' for Mflights).

3.3.1.1.4 Step 4 - Manage the priority value flights (Nflights)

Nflights are defined by the fact that they have no Margins defined on its and not "P" and not "S" as priority value. Lflights are part of Nflights management but with a priority = to 1000.

The objective is to rearrange the sequence of the flight according to priority given by the AU. It is implemented by sorting AU flights by priority then by Baseline time. This ordered list is used to assign slots in the remaining AU Local slots of the AU.

This priority value could be specifically given for the flight or given by the default one.

The first part of this algorithm is to get all the AU flights to be used for this step; All AU flights except the one previously assigned: Pflights, Mflights, and dBflights and the Sflights.

Then sort flights by priority then Baseline times: Lflights the Lowest priority (priority = 1000).

- Then Assign **Nflights** on remaining slots in the ordered list on empty slots (not before its Reference time of course).

Dubbio B: ecco qua, i Bflights NON sono menzionati, quindi in teoria devono essere riassegnati. Il che non ha senso perché non hanno un prioriry number assegnato, quindi anche volendo riassegnarli(che non ha senso perché si vuole lasciarli dove sono) non si capisce come

- If a flight could not be assigned on an empty slot due to its reference time, use the same function then for the Margin flights: **<u>Function "Manage Time Solution"</u>** but with a target time value at the end of the "UDPP Measure". In this case fill the empty slot by the end of local slot list.

3.3.1.1.5 Step 5 - Manage the Suspended flights

The assignment of the Suspended flights (Sflights) is done in this step by giving to these flights the time of the end of the hotspot (set its local UDPP time to the end of the UDPP Measure). The real Time will be given at the end of the Merge phase see part (3) of the graphic of the General UDPP algorithm view.

2.1.1.3 Dynamic Management of Time Not Before and Time Not After

The management of TNA and TNB could be generalised to each flight of all the AUs. This 2 values become times constraint to assign flights to the right slot.

These values are not necessary issued by the Margin field TNB and TNA given by the AU but calculated according to the status of the flight and the type of priority given on it.

The calculation is done in 3 steps, 1) The calculation of the status of the flights, 2) the static value of the TNB and TNA and then 3) the validity of TNA according to the status of the flight.

1) Status of the flight:

The status of a flight, is given by the current time, and determines if the flight is pre-allocated (already airborne …) or not. This status is expressed by "Max prioritisation time" and given by the formula:

$$(MaxPrioritisationTime = CTOT + Flight\ duration + 20mn) > Current\ time$$

If the current time is earlier then the MaxPrioritisationTime, then the flight must be considered as pre-allocated at its current CTOT.

2) Static value of TNB and TNA:

TNB = Margin TNB value TNB if exist

or Reference time – EarlyScheduleTime for Pflights

or Reference time for others flights

TNA = Margin TN value if exist

or end of UDPP measure

3) Validity of TNB and TNA value:

Final TNB = latest time between (TNB, MaxPrioritisationTime): according to the current time, MaxPrioritisationTime can replace the reference time to calculate the UDPP output.

Final TNA = earliest time between (TNA, end of the UDPP measure)

The dynamic approach of the TNA and TNB avoid giving impossible solution to flights.

2.1.1.4 Generic functions to manage flight position

DUBBIO A
tutti a seguire

3.3.1.1.6 Function - Manage Time Solution

The objective of this function is to assign a slot close or earlier to the flight 'Time not After', with minimum impact on previously assigned slots.

This function has, as input, the flight to manage and its 'Time not After' objective associated.

It uses the slots list, with already assigned flights.

1st Try to assigned slot with equal or earlier objective, by calling first Function: Manage Solution Earlier.

2nd If no Earlier slot solution is possible, assign first later available slot.

fin qui ok

3.3.1.1.7 Function - Manage Solution Earlier

This function called by 'Manage Time Solution', try to find an **equal or earlier slot** to be assigned to a flight.

For that, this function loops from the target slot of the desired slot to the 1st slot of the list (earliest).

loops and what?

And Call the Function: Move flight Earlier

a ogni iterazione o alla fine? in ambo i casi non ha senso

And Return the slot assigned if succeed or a negative value if not possible

3.3.1.1.8 Function – Move Flight Earlier

This function is **the heart of the Margin management**. It's a recursive function to find a slot earlier by pushing already used slots according to their possibilities.

In algorithm language:

- Loop until an earlier slot has to be tested: An earlier slot has to be tested if the target slot is used, and the flight to move, to free it, is blocked according to its schedule.
  - Try to assign to the target flights the target slot time (target time is the one before going over the Margin 'Time not After').
  - If the slot is empty (slot not already used) gives it to the target flights. This end the function.
  - If the slot is already used:

qui non ho proprio capito nulla: io nella tesi ho spiegato il meccanismo che credo vogliano implementare Se ho capito giusto, quello funziona, questo non ho proprio idea

Test if possible to shift already assign flights on it to earlier slot, to free the slot (because previously assign flight must have an earlier slot) by calling **Function: Move flight Earlier** (itself on flight using the slot). This is the recursive call of this function.

If the shift is possible, assign the target flight to the target slot and return the free slot. By this, all the movable flights (driven by the level of recursively) shift the other flights needed to make it free (done by finishing the recursive call of the function).

If the shift is not possible (no slot available before, or time too early according to reference time (schedule)), return a negative value corresponding to the blocking target slot.

For information: the management of the shift flights earlier (make the slot free) is implemented by a recursive call to shift all the already affected flights with the test of the possible shift. This recursive function returns the value of the shift to be done or the fact that it is not possible. The real shift is done by the calling function (itself but recursively before) when the result is positive and gives the slot to be shift. A shift of a flight could be done if the reference time is earlier or equal to the target time to shift. To be noted that the fact that if a flight in the slot list is not shiftable, does mean that an earlier flight cannot be taken as target slot to fulfil the Time not After of the flight to assign.

3.3.2 Local Flight Time Assignment

Input:
AU Intermediate Local Slots List

AU sorted flight List (by ranking algorithm)

Priority values (to manage Sflights)

AU parameters (Max delay for Protection)

Output:
AU Local Slots List

Objective:
The objective of this final local part is to calculate AU Local Slot time to be used later as an input of the merging function integrating all AUs inputs. NB: Airborne and terminated flights keep the same current time in slot list.

The previous "Local ranking method" phase (previous chapter) gives a priority sorted AU Flight list, and a AU Slot list.

The Local Flight Time Assignment puts all AU sorted flights in the AU Slot list (could be changed by Pflights management).

Synopsis:

Loop on all flights in sorted AU flight list (given by the selected ranking method)

[Rule_12]   If the flight is a Sflight, the time assigned to it corresponds to the End Of "UDPP Measure" minus 5 seconds to be sure that the flight will be managed as a flight inside the "UDPP Measure" (it's an intermediate solution, the final real time will be given in the merge function because it depends on the other Suspended flights from the other AUs and possible holes in the final sequence).

[Rule_13]   Else Assign the first available AU Time Slot equal or after the Psolution for Pflights and the flight schedule for the others. To be noted that "HotspotFlightEarlierSchedule" time has been used for Psolution and not used here for the local solution because the objective is not to optimise the resource at this stage.
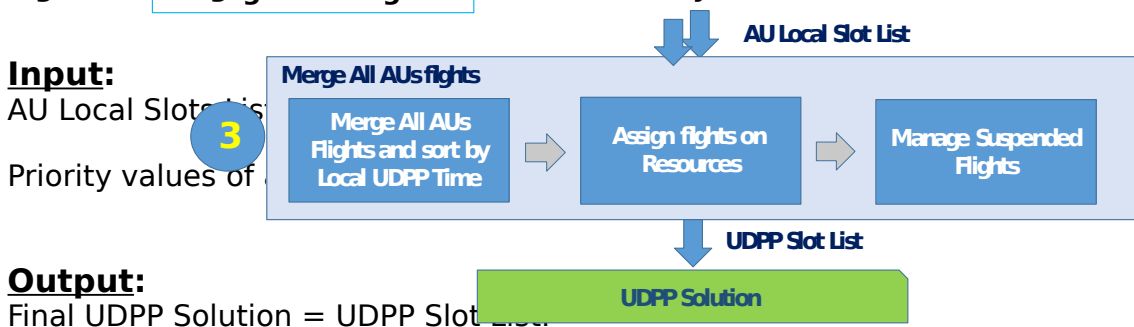
End Loop

3.4 The Merge function

The Merge function is triggered by the Local Slot assignment done at each AU

WhatIf or Commit demand. It's the last step to generate UDPP slot times.

Figure 6: Merge function And Absolute Priority

Input:
AU Local Slot List

Priority values of AUs

Output:
Final UDPP Solution = UDPP Slot List

Objective:
The objective of this function is to merge the local AU Assigned time of all flights from all AUs (given by the previous phase). All Sflights will be first excluded from this merge and re-introduced after all other flights.

[Rule_14] The merge function performs the following actions:

Sort all AU "UDPP Measure" flights by the AU Local Time Slot (if same Assigned Time then ordered by the Baseline Slot Time), ignoring the Suspended flights (Sflights).

[Rule_15] Assigned each flight on the managed resource (e.g. runway) in an optimum way: make the same Slot allocation than the one performed to create the Baseline Slot List (CASA-like algorithm) but instead of taking flights Reference (Schedule) as input, take All AUs Local Slot List, and Ignoring first all Suspended flights, but also using HotspotFlightEarlierShedule as possible departure time (to optimise the resource) (see after).

[Rule_16] Apply the following rules optimisation:

Use the HotspotFlightEarlierSchedule on all flights to optimise the resource (e.g. runway throughput): get a slot later or equal than [Schedule time - HotspotFlightEarlierShedule]
nb: This optimisation is based on the usability of the resources given by the different constraints provided by the resource owner (CCS).

[Rule_17] Then assign Suspended flights (sorted by Baseline Time):

First Sort Sflights by Baseline time then, 2 options are possible and are actually implemented waiting for AUs feedbacks:

o Starting from the beginning of the "UDPP Measure", and where there is a hole in the sequence (available time to add a flight: enough time before and after a possible slot), put the Sflight, and loop until no more Sflight to assign (some Sflights could be out of the "UDPP Measure").

o Starting from the last assigned flight in the "UDPP Measure" and continue the Merge with the Suspended flights Sflight, not touching existing flight time even out of the "UDPP Measure" (some Sflights could be out of the "UDPP Measure").