Appendix M Demonstration Exercise EXE-VLD-08-002 (Zürich Collaborative tool AU / ATC / NM) Report

M.1 Summary of the Demonstration Exercise EXE-VLD-08-002 Plan

As described in the DEMOP xStream VLD-08-002 the scope of this exercise was to use a collaborative tool between ATC, AUs and NM to establish the optimal arrival sequence integrating airspace users' preferences. For this purpose the exercise used the UDPP prototype, which was developed in the frame of the PJ07.

Airspace users receive the possibility to priorities flights flexible in arrival capacity constrained situations regarding their preferences by using the UDPP concept. Therefore the main goals of the exercise were to improve service for AUs by providing more flexibility and to improve AUs operation, e.g. in terms of ensuring passengers connections, aircraft rotation, curfew management and crew duty times.

M.1.1 Exercise description and scope

The trials within this exercise applied the UDPP concept to Zurich arrivals during capacity constraint situations. As Zurich Airport faces regularly arrival capacity limitation situations (mostly between 8 and 10 UTC), the UDPP concept would be of huge relevance to improve the Airspace Users flexibility during airport congestion.

The EXE-VLD-08-002 targeted to focus on the algorithm "Fleet Delay Reordering" (FDR), which will allow AUs to assign priority order to their own flights in case of Zurich arrival regulation.

The FDR algorithm would give the AU the possibility to reduce their costs of delay due to ensuring passenger connections and preventing rebooking, solving proactively night ban issues or decreasing rotation delay by re-arranging their own flights' sequence, while ensuring equity between all AUs, i.e. no negative impact is transmitted on other AUs.

During this exercise two different trials were performed:

- UDPP Simulation: was used as testing and validation of the use of the UDPP prototype for EXE-VLD-08-002 (UDPP connection to test platform INNOVE)
- UDPP Shadow Mode Trial: UDPP concept should be tested in a more dynamic and volatile environment (UDPP connection to the ECTL NMVP system)

During both trials two different scenarios were compared with each other:

- Reference Scenario(s): current operations, as no collaborative tool (UDPP) is available to integrate priority requests from AU
- Solution Scenario(s): changed arrival times/arrival sequence due to submission of flight priorities by AU

M.1.2 Summary of Demonstration Exercise EXE-VLD-08-002 Demonstration Objectives and success criteria

The objectives and success criteria for EXE-VLD-08-002 are provided in the xStream DEMOR main document in chapter 3.4 "Summary of the xStream Demonstration Plan".

M.1.3 Summary of Demonstration Exercise EXE-VLD-08-002 Demonstration scenarios

UDPP Simulation

For this quantitative assessment, there were fourteen files with data of reference and UDPP trials available. The trials were performed in the night from September 30 to October 1, 2017 and were provided by skyguide. Before running the scenarios, fourteen steps were defined, all differentiated by some stepwise modifications. More details are provided and described in the PJ07-02 VALR Appendix B. Eleven of these steps were conducted, but only in four cases, data of both, Reference and UDPP, were available for a direct comparison (Table 1).

Step	Reference	UDPP
1		
2	x	
3	x	x
4		
5	x	x
6		x
7		x
8		x
9	x	
10	x	x
11		x
12	x	x
13		
14		
Sum	6	8

Table 1: Available Reference and UDPP trial data files for the fourteen defined steps. The green lines mark steps with both Reference and UDPP scenarios, the black rows steps with only one available scenario, and the red ones steps without related data.

For a meaningful evaluation, only steps where the Reference as well as the UDPP scenarios were available are part of the following quantitative assessment. This applies to the steps 3, 5, 10, and 12.

Evaluating these simulation results, some limitations had to take into account. Not all network effects were covered. Only one day of traffic was simulated in a small time-window. There is no information available on how representative this day was in relation of the air traffic of a complete year. For modelling the CASA algorithm, some not detailed specified simplifications were made and may come into effect during analysis.

UDPP Shadow Mode Trial

In comparison to the UDPP simulation and in order to test the consisting prototype application in a more dynamic and ops-similar environment, which more closely corresponds to the live situation in the European airspace, the UDPP prototype is connected to NMVP instead of INNOVE during the Shadow Mode Trial (as the UDPP prototype was not mature enough at this stage to conduct live trials).

Further changes to the previous tested and used prototype (EXE-07.02.06) are that SWISS has developed its own FOC UI for flight prioritisation, and that on the APOC side only a regulation can be created to provoke a Capacity Constraint Situation (CCS), but the resulting impact onto the airport will be not simulated.

By using the APOC functionality, it is possible to create the same operational regulation on the UDPP server as it is implemented in the live system/European network (reference scenario) to compare the UDPP prioritisation results with the real operational situation and to assess the impact through UDPP.

To accomplish this, the UDPP server is connected to the NMVP system. Additionally, the same arrival regulation (UDPP measure) as in the live system is implemented on the UDPP server every day during the shadow.

There were two limitations during these Shadow-mode trials:

- The UDPP results (prioritized flights, with new ATFCM delay, new CTOT and new arrival times) are not committed to NMVP. The impact of the UDPP onto the network and the persistence of the UDPP prioritization are not assessed here.

- The other limitation with using the UDPP APOC functionality to create a UDPP measure is, that there is no possibility of stepwise capacity changes. For one created UDPP measure there is only one capacity rate setting possible.

The Shadow Mode Trial run from 3th of September to 4th of October 2019 and the daily trial procedure was the following

1. UDPP measure creation (same as daily LSZHA regulation) --> transmission to NMVP.
2. Request of all affected flights from NMVP.
3. Display of all affected flights in FOC with operational consequences for AU.
4. Flight prioritisation (FDR and SFP algorithm).
5. WhatIf request to UDPP server:
    a. Display of all affected flights in FOC with new prioritized arrival times and new operational consequences for AU.
    b. Possible refinement of priorities --> whatIf request to UDPP server (5.).

6. Commit of prioritisation (for now not to NMVP, but saving the prioritisation results (solution scenario)).

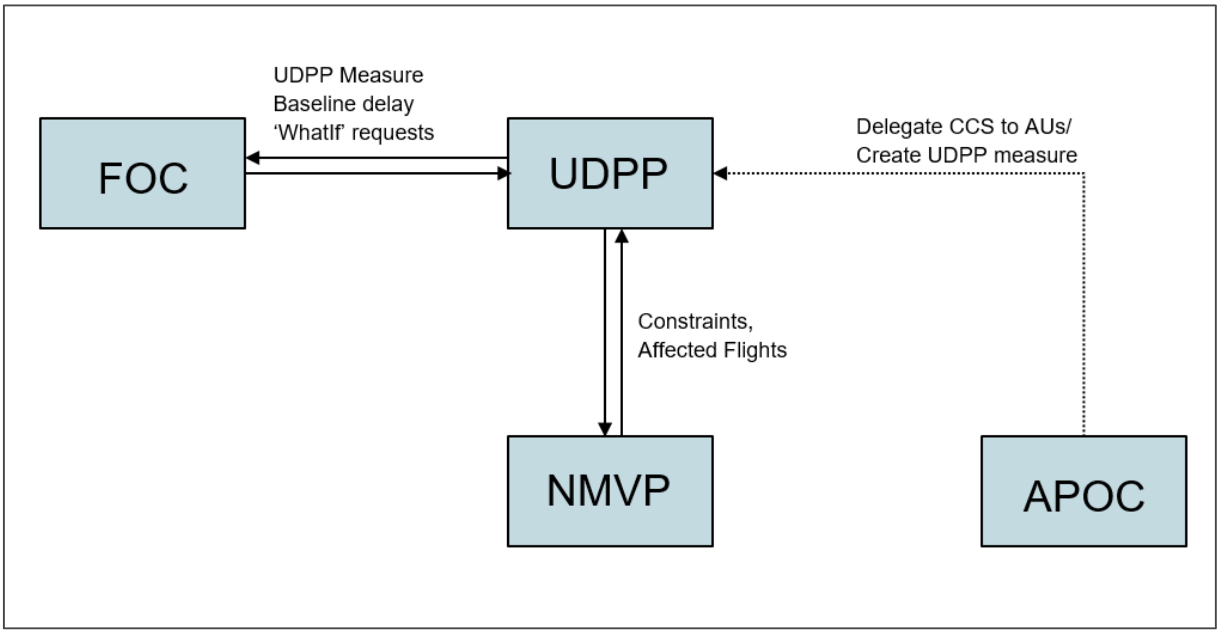

Figure 1: UDPP Shadow Mode trial procedure

To perform the flight prioritisation as AU there are two different approaches to do so:

- Manual flight prioritisation to choose and favour operationally important flights.
- Automatic flight prioritisation to improve the overall operational situation for AU.

During the shadow mode trial the automatic flight prioritisation took place every 15 minutes to be able to compare the possible changes and benefits for AUs through UDPP at different times.

M.1.4 Summary of Demonstration Exercise EXE-VLD-08-002 Demonstration Assumptions

The assumptions concerning EXE-VLD-08-002 are provided in the xStream DEMOR main document, in chapter 3.4 "Summary of the xStream Demonstration Plan".

M.2 Deviation from the planned activities

UDPP Simulation

For the evaluation of the traffic scenarios regarding the selected KPAs, a sequence of steps were predefined to cover a broad bandwidth of situations in the Reference and UDPP simulations. The steps were envisaged to recognize the effects of different changes in the constraint parameters of sequence planning. During the simulation runs, limitations of the scenarios and the software resulted in the impossibility to simulate all defined steps with the Reference and UDPP scenarios. Aggravatingly, the steps were not performed in the planned order. At the end, only 14 of the envisaged 28 steps were simulated in an adequate quality to use them for a conclusive analysis.

UDPP Shadow Mode Trial

The following deviations can be listed for the Shadow Mode trial:

- No commit of UDPP prioritisation results to NMVP (network impact could not be assessed).
- Participation of FMP in shadow mode trial was not possible and therefore no assessment of local ANSP impact was performed.

M.3 Demonstration Exercise EXE-VLD-08-002 Results

M.3.1 Summary of Demonstration Exercise EXE-VLD-08-002 Demonstration Results

See DEMOR main document chapter 4.1.3.2.

M.3.2 UDPP Simulation 2018

1. Results per KPA

a. KPA Cost Efficiency

The UDPP Simulation did not provide the possibility to assess the KPA Cost Efficiency. This assessment was later possible in the shadow mode trial.

b. KPA Capacity

i. Quantitative Assessment

As it was only a simulation with simulated arrival slots, there is no possibility to assess the real ATFCM delay. Only the UDPP simulated delay could be taken into account, which should be similar to the ATFCM delay.

In the following analysis, only the period of time in which the created UDPP measure is valid is considered. Due to the UDPP delay, flights are delayed, and due to the subsequent flight prioritisation, flights are pushed out of this time window. Therefore flights are missing in the reflected timeframe and their delay is not included in the following analysis.

Total UDPP Delay

The total UDPP delay describes the sum of delays in minutes of all individual flights in the respective trials. It is an indicator of the frequency and the length of delays in a given scenario or timeframe. The results listed below in Table 2 and in Figure 2 were calculated and charted by DLR with Microsoft Excel.

Scenario	3	5	10	12
Reference [min]	593	543	616	604
UDPP [min]	474	435	410	461
Difference [min]	119	108	206	143
Difference [%]	-20	-20	-33	-24

Table 2: Total UDPP delay in minutes for the Reference and the UDPP scenarios in step 3, 5, 10, and 12. All numbers were rounded.

The following Figure 2 shows the total UDPP delay in minutes for eight scenarios in the considered steps as time measured at the threshold.

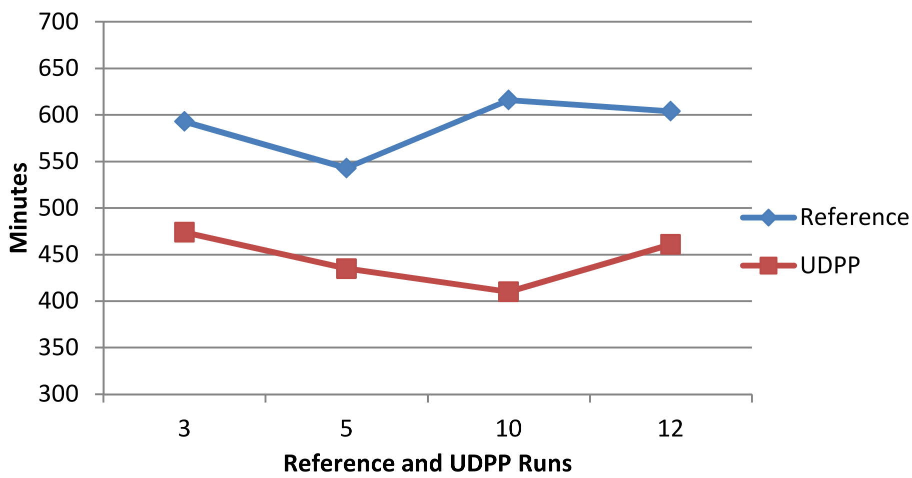

Figure 2: Total UDPP delay in minutes for the four considered Reference and UDPP scenarios.

Through the interventions in the four considered steps, the sum of the UDPP delay for the flight was noticeable reduced. The absolute reductions were between 108 and 206 minutes, these come up to a reduction of 20% to 33%. The best relative and absolute results were achieved in Step 10 with a delay of 410 minutes in the UDPP scenario in relation to 616 Minutes in the Reference one.

Average UDPP Delay per flight (per airline)

The average UDPP delay per flight in minutes indicates the length of the mean delays in minutes of arrivals in a given scenario or timeframe. The sum of all individual aircraft delays of a timeframe or scenario is the total UDPP delay. To make statements about the delay of airline regarding an equal distribution of delays the average UDPP delay per flight should be calculated individual for every airline in a given scenario. Unfortunately, in the evaluated scenario, only the SWISS can be found with a sufficient number of aircraft to make a significant statement. To have an opportunity to compare the delays per airline, the Edelweiss airline is used for evaluation as this is the only other airline with at least a few flights contained in the limited simulation time window (08:20-10:00lcl). All other airlines appear with two or less aircraft per scenario only and thus are not suited for a statistical evaluation.

The results for the average UDPP delay per flight are listed below in and in Table 3 and Figure 3. They were calculated and charted by DLR with Microsoft Excel.

Step	3	5	10	12	Average
Reference [min]	10.2	9.5	11.0	11.2	10.5
UDPP [min]	8.9	8.1	7.6	8.5	8.3
Difference [%]	12.7	14.7	30.9	24.1	21.0

Table 3: Average UDPP delay per flight in minutes for the Reference and the UDPP scenarios in step 3, 5, 10, and 12. All values were rounded.

The average drop in UDPP delay were 21.0% between the Reference and the UDPP scenario steps 3, 5, 10, and 12. The average delay reduction between both scenarios were 2.2 Minutes (2:12 Minutes). The biggest improvement show Step 10 with a reduction of 3.4 Minutes (3:24 minutes), which corresponds to a reduction of nearly 31%. Also Step 12 benefits in the UDPP scenario by 2.7 Minutes (2:42 Minutes) less average UDPP delay per flight. The reduction in Step 3 and 5 are with nearly 13% and nearly 15% less distinct.

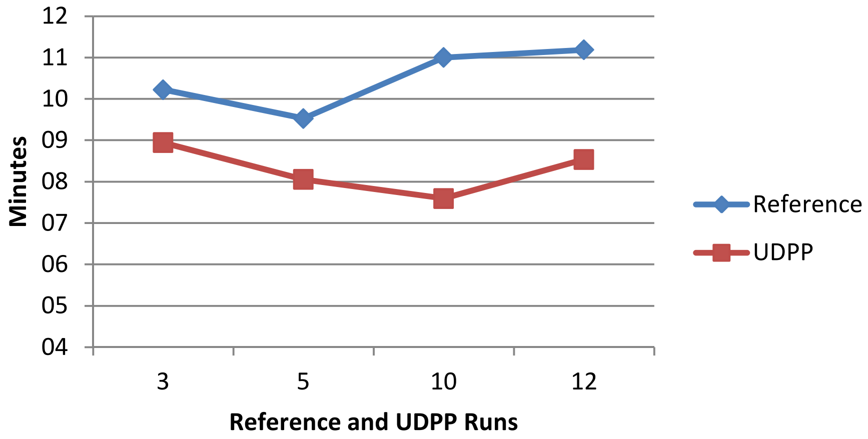

Figure 3: Average UDPP delay per flight in minutes for the four considered Reference and UDPP scenarios.

Cumulated, the UDPP delay per flight was in every comparable Step in the UDPP scenario less than in the related Reference.

Viewing at the UDPP delay per airline and flight, the comparability is limited, because SWISS (SWR) and Edelweiss (EDW) were the only airlines with more than one flight in the simulation trials. Looking at the average UDPP delays of these two airlines, no differences are observable for EDW, but some significant changes are visible for SWR (Table 3 and Table 4). When considering the average values for delay in minutes, it should be taken into account that the number of considered Steps in the Reference and the UDPP scenario were unequal.

Reference	Step 3	Step 5	Step 9	Step 10	Step 12	Average	SD
SWR [min]	11.6	10.7	11.1	12.1	12.5	11.6	0.73
EDW [min]	10.3	9.4	9.4	10.3	10.3	10.0	0.49

Table 4: Average UDPP delay per flight in minutes, broken down by SWR and EDW in the considered Steps of the Reference scenarios. All values were rounded.

UDPP	Step 3	Step 5	Step 6	Step 8	Step 10	Step 11	Step 12	Average	SD
SWR [min]	10.5	9.2	10.5	7.6	8.1	8.2	9.5	9.1	1.3
EDW [min]	10.7	9.7	9.7	9.4	10.1	10.1	10.1	10.0	0.50

Table 5: Average UDPP delay per flight in minutes, broken down by SWR and EDW in the considered Steps of the UDPP scenarios. All values were rounded.

Concentrating on the differences between Reference and UDPP for SWR only, Figure 4 shows a noticeable reduction of delay per flight in the UDPP scenarios.

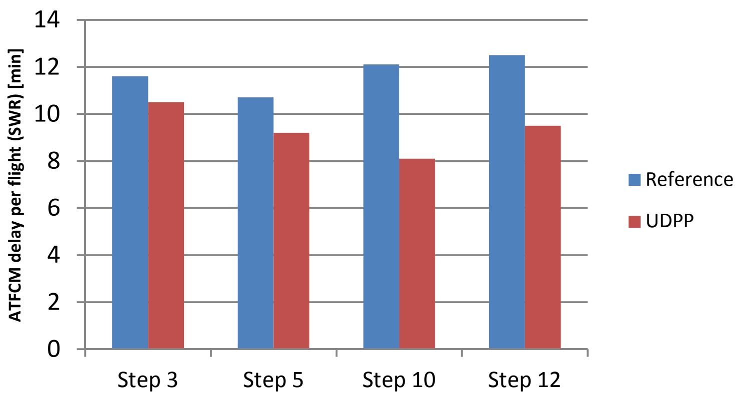

Figure 4: Average UDPP delay per flight in minutes for SWR airline only.

As in the results of all flights in the scenarios independently of the airline (Figure 3), Step 10 produced with 4.0 Minutes (4:00 Minutes) the most visible average reduction in delay-minutes per flight.

ii. Qualitative Assessment

Not foreseen.

c. KPA Flexibility

The UDPP Simulation did not provide the possibility to assess the KPA Flexibility. This assessment was later possible in the shadow mode trial.

M.3.3 Shadow Mode Trial 2019

1. Results per KPA

For the analysis of cost efficiency, all flight prioritisations saved during the trial phase were considered. No difference was made between manual and automatic flight prioritisation.

The automatic prioritisations were performed from 3:30 hours before the measure start and were conducted every 15 minutes. The automatic flight prioritisation has been terminated after all affected flights have departed and no flight prioritisation has been possible anymore.

Since the number of saved flight prioritisations varies slightly each trial day, the best saved UDPP result per 30 minutes was considered for the following analyses for the period from 3:30 hours before UDPP measure start to the actual measure start. This allows a comparison of UDPP results over time and as well the identification of the optimal time to perform a flight prioritization.

For the analysis, the Reference Scenario is compared with the Solution Scenario.

a. KPA Cost Efficiency

In order to evaluate the cost efficiency of UDPP for AUs, the number of critical passenger connections and the respective transfer time are analysed as well as the total operational benefit of all affected flights.

i. Quantitative Assessment

Critical Passenger Connections:

The following graph shows how many critical connecting passengers (with a too short transfer time and thus probably misconnections) on average could be guaranteed a sufficient transfer time through UDPP flight prioritisation, which is directly related to saved compensation and rebooking cost. It can be observed that in the period from 07:00 to 07:30 UTC, on average for 24 connecting passengers, a sufficient transfer time and thus the greatest improvement can be achieved over time. This number reflects an average improvement of 40 %.

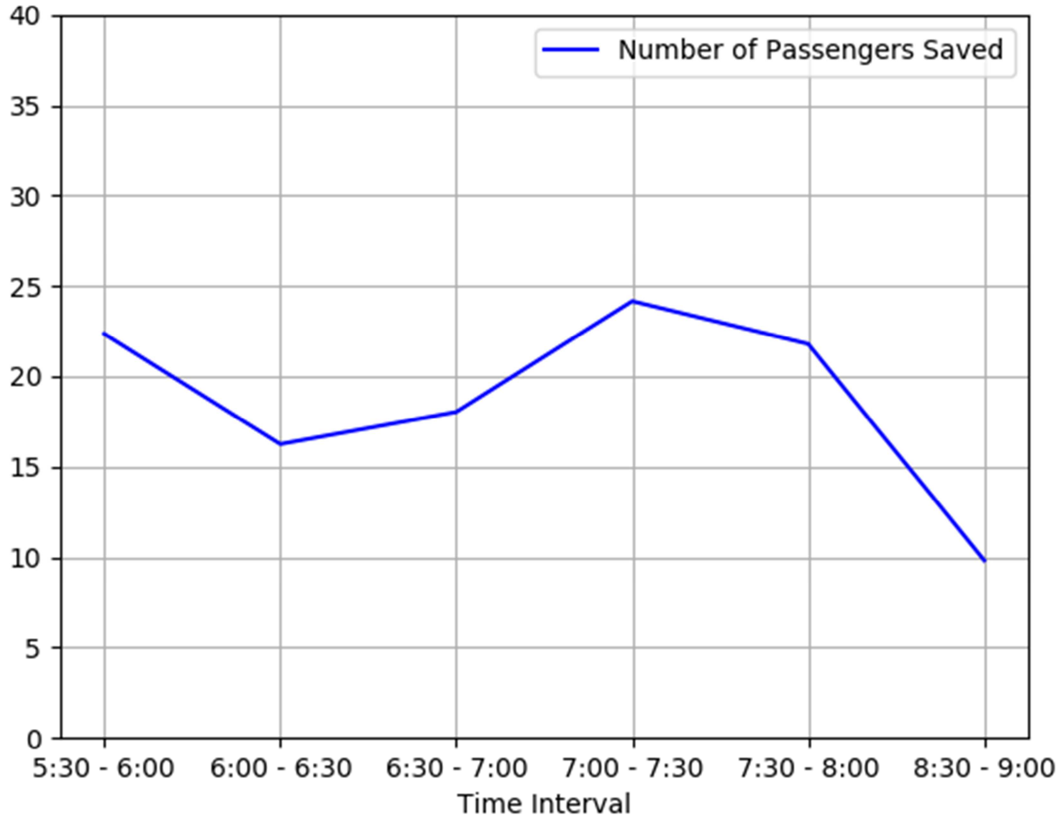

Figure 5: Temporal development of the average number of connecting passengers with improved transfer time

Total Operational Benefit:

To assess the total operational benefit during the trial for SWISS/AU a flight value was calculated for each affected flight, which takes into account various operational criteria as passenger connections, aircraft rotations and crew issues. The improvement of these criteria has a financial benefit for AUs, which cannot be calculated easily.

Therefore, the following figure shows the total operational benefits during the UDPP shadow mode trial by showing the average percentage improvement of the calculated overall flight value of all affected flights at different times.

In the time window from 07:00 to 07:30 UTC, during which on average the highest absolute number of critical transfer passengers can be saved, is an additional percentage improvement of 65 % in the overall operational benefit achieved. Since the total operational benefit is not broken down further according to the individual criteria, the following figure presents in addition to the percentage improvement of the total operational benefit as well the percentage improvement of the connecting passengers, which is enclosed in the total operational benefit.

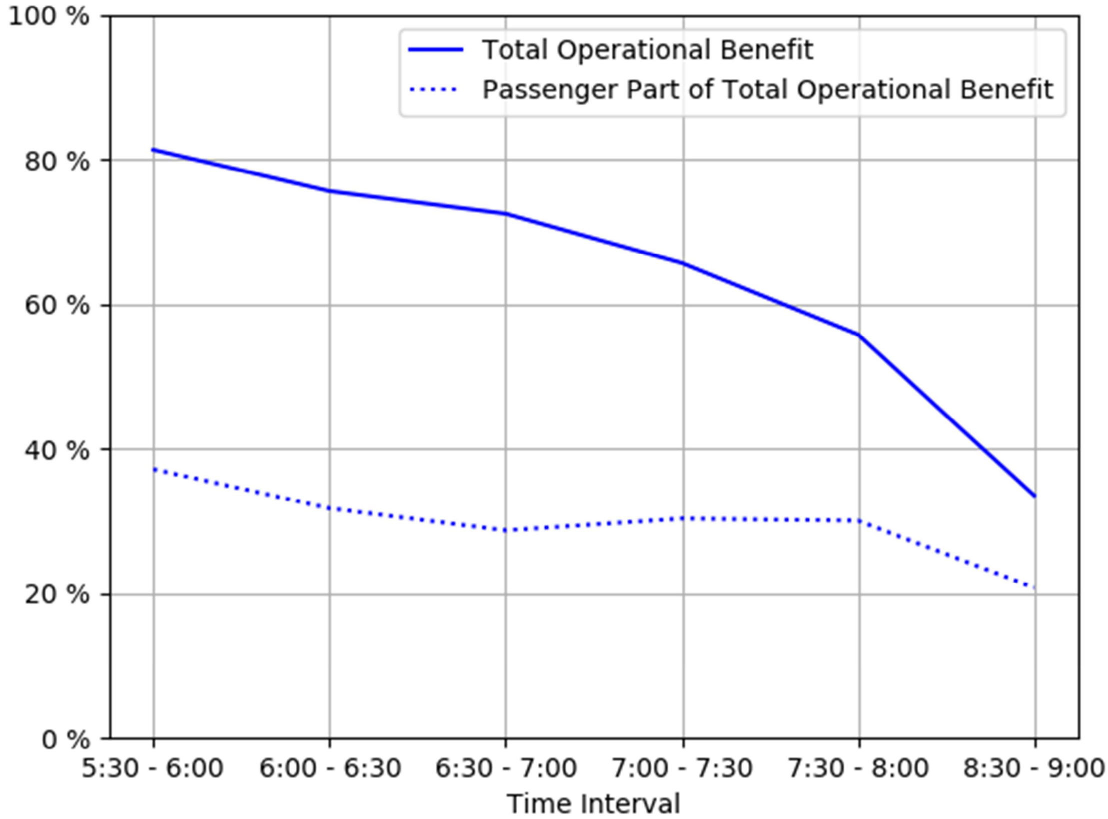

Figure 6: Total operational benefit in percentage

ii. Qualitative Assessment

With ensuring passenger connections through flight prioritisation the UDPP concept provides a huge financial benefit to airspace users as misconnections could be prevented and therefore less passengers have to be rebooked. Another benefit which effects the cost efficiency positively is the avoidance of reactive delay on operational important flights. Therefore night ban issues can be solved in advance and additional costs through night ban violations can be avoided.

A further financial advantage can also be provided by giving preference to flights with crew duty problems. With this approach flight cancellations due to crew duty limitations and therefore high non-performance-costs can be prevented.

b. KPA Capacity

i. Quantitative Assessment

As during the Shadow Mode Trial no NMVP commit of the UDPP prioritisations took place, there is no possibility to assess the ATFCM delay. Instead of using ATFCM delay the UDPP server simulates the CASA slot allocation and calculates the flight delays with the simulated slots. Therefore only the UDPP simulated delay could be taken into account, which should be similar to the ATFCM delay.

In the following figure the reference delay is compared with the UDPP delay of all affected flights. This represents the change in the delay in order to draw a conclusion on the impact of UDPP.

As shown in the KPA Cost efficiency, the best time window would be between 07:00-07:30. In particular during that time frame the difference of the summed UDPP delay of all flights is close to zero. There are outliers, but the median UDPP delay difference is zero, and the mean is marginal higher than zero. This means the total amount of delay minutes through UDPP regulation will stay almost the same for all flights, therefore no negative impact for other airlines can be shown and equity is ensured.

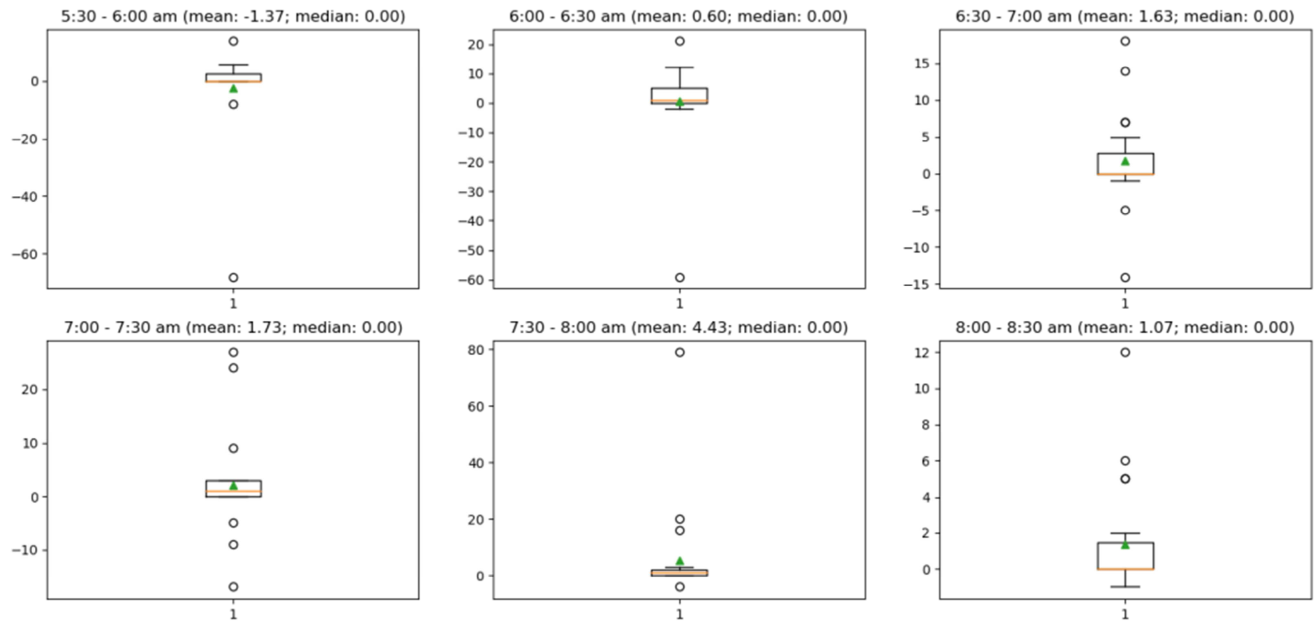

Figure 7: Delay distribution during the UDPP trial phase

ii. Qualitative Assessment

Not foreseen.

c. KPA Flexibility

i. Quantitative Assessment

The following analysis shows how many flights have been assigned a new arrival time by the UDPP prioritization. In particular, Figure 8 shows the percentage of flights that have been changed with UDPP. It indicates that for 40% of the flights the arrival time changed more than ten minutes and for even 60% of the flights it changed more than three minutes. This clearly specifies the high amount of flexibility provided to Airspace Users by UDPP and their need for prioritisation.

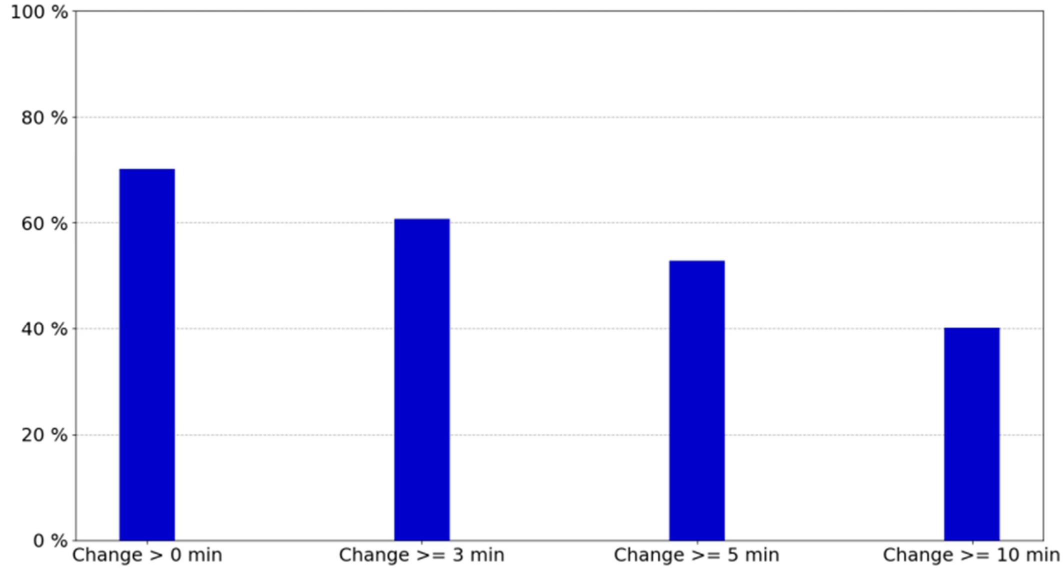

Figure 8 Average percentage of flights affected through UDPP prioritization

Regarding the distribution of the percentage of flights affected per day over the trial period, see Figure 9, large variations are displayed. This clearly shows that the prioritization is largely dependent on the specific delay situation on the respective day. A dynamic UDPP is therefore of the utmost importance. Furthermore, the necessity for UDPP and the extent of UDPP differs each day of operations, but is always present and large. Throughout almost the entire period at least 20% of the flights were changed by more than ten minutes with an average much higher as shown in Figure 9.

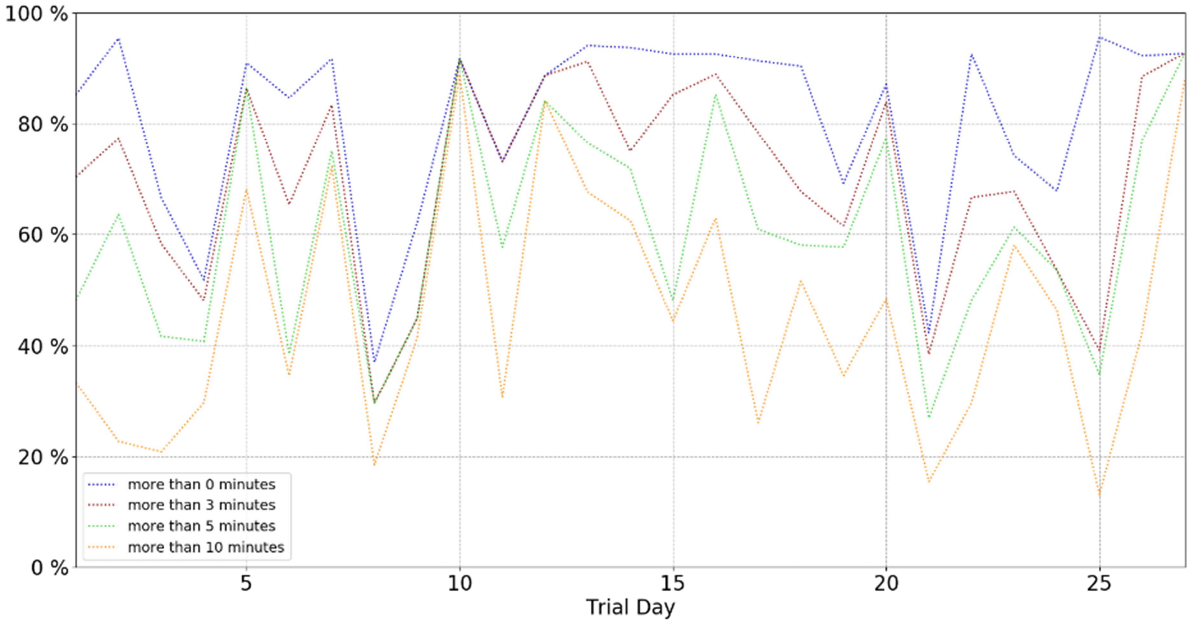

Figure 9: Percentage of flights affected through UDPP prioritization over trial period

The majority of all flights during the daily regulation and in this UDPP trial time frame were from one Airspace User, being the hub carrier. Therefore, the negative impact of delays are also major for this particular Airspace User. All hub carriers can consequently even more benefit from the flexibility provided with UDPP as other Airspace Users, but which also can benefit.

ii. Qualitative Assessment

This exercise proved in shadow mode that the UDPP concept can optimize an airline's flight operations during capacity constraint situations in terms of using multiple criteria. The UDPP concept provides therefore AUs with the flexibility to manage their operations according to their preferences. Additionally the flight prioritization concept requires only a very low manual workload and provides a more powerful possibility to optimise the overall arrival sequence than using the NM slot swap functionality. With this concept the AUs will receive for the first time the possibility to optimize their flights flexible and in a holistic approach.

2. Results impacting regulation and standardisation initiatives

The positive exercise results support the further regulation and standardisation initiatives regarding the involvement of AU preferences in arrival management.

M.3.4 Analysis of Exercises Results per Demonstration objective

1. EXE-VLD-08-002 OBJ-VLD-04-001 Results

This objective was to show that xStream operational improvements increase cost efficiency from more efficient processes for airspace user.

The corresponding success criterion is fulfilled when flight efficiency is increased and flight management / flight coordination costs are reduced.

According to the assessment performed for the shadow mode scenario the benefits in terms of cost efficiency for the airspace user could clearly be determined.

This objective can be considered fulfilled.

2. EXE-VLD-08-002 OBJ-VLD-05-003 Results

This objective was to show that xStream operational improvements lead to a reduction of ATFCM measures.

The corresponding success criterion is fulfilled when flight delay caused by ATFCM is reduced.

This objective was not required by the demonstration plan and in contrast to the success criterion the goal for UDPP was not to reduce delay in total but to provide a possibilty for AU to redistribute the delay over the own flights without negative impact for other remaining flights. This was confirmed by the assessment.

Therefore the objective can still not be considered fulfilled.

3. EXE-VLD-08-002 OBJ-VLD-06-001 Results

This objective was to show that xStream operational improvements enable a more flexible management of arriving flights by aircraft operators / airspace users.

The corresponding success criterion is fulfilled when communication and consideration of airspace user / aircraft operator preferences as part of arrival management process is increased.

According to qualitative assessment, UDPP provides clear flexibility benefits to airspace users.

The objective can be considered fulfilled.

M.3.5 Unexpected Behaviours/Results

UDPP Simulation

During simulations, some slot allocation failures occurred, which may have an influence on the evaluation results.

UDPP Shadow Mode Trial

No unexpected behaviour during shadow mode trial.

M.3.6 Confidence in the Demonstration Results

1. Level of significance/limitations of Demonstration Exercise Results

For a quantitative assessment, the number of useable datasets has an impact on the results. For the statistical evaluation, the number of data points should be as elaborately as possible, which was not given in all to be compared baseline and solution datasets. This hampers the possibility to make assertions about the significance of results and trends.

For the UDPP-Simulation, another impact results by the way the validated timeframe was defined. The data analysis was performed with a fixed time window of two hours on the trial day. For this reason, aircraft, which scheduled target times were shifted out of these two hours in the Reference or in the UDPP scenario were not taken into account and affected in this way the delay results, as they were not count in both scenarios. Another option would be the data analysis with a fixed aircraft pool. In this case, all delays of the aircraft independently of the time where they were scheduled, were considered. In this case, statements about the traffic flows regarding fixed timeframes would be limited.

2. Quality of Demonstration Exercise Results

In both scenarios, UDPP simulation as well as shadow mode scenario, comparability issues do not play a role in contrast to other PJ25 live trials. It can therefore be expected that the error range is relatively small here.

However, it has to be noted that simulations and shadow mode trials results may deviate to a certain extend from real operational benefits due to simplifications / assumptions. Therefore the results described here should be confirmed in a repetition of the trials in a fully operational configuration.

3. Significance of Demonstration Exercises Results

As described earlier, the shadow-mode demonstrated the UDPP mechanism and its associated results based on NMVP flights lists and ATFCM inputs. The simulations and shadow-mode trials were run in a local environment and the impact on the network could not be assessed yet. Therefore as no commit to NMVP could be trialed during this timeframe, the results cannot be stamped valid in a real operational environment.

M.4 Conclusions

For ATC, two aircraft have the same value, but for AUs each flight has a different value. During capacity constraint situations and the resulting flight delays, this fact becomes very important for airspace users. For AUs it is hardly impossible to steer their own flights and their operations according to their needs during these situations.

By using the UDPP concept, AUs have the opportunity to manage their flights during capacity constraint situations regarding their preferences and priorities to ensure for example passengers' connections, aircraft & crew rotation times, aircraft maintenance etc.

These AUs preferences and priorities are closely linked to the value of each individual flight, which need to be determined according to a variety of criteria such as passenger connections, aircraft rotation time, required maintenance, crew duty times and many others.

The UDPP concept enables AUs to set priorities for flights in an easy way and aims to see directly the outcome of each prioritisation through a whatIf request to the UDPP server.

With each UDPP whatIf request and the recalculation of the arrival times of all affected flights, as well as presenting the operational impact, the AU can decide conveniently for the right priorities for its flights.

With a small AU fleet, or a small amount of affected flights, it is easy to have an overview of all these flights as well as of the operational consequences of each flight delay and to decide which flights need to be prioritised to improve the AUs operation.

If the number of affected flights and the flight delays increase through a high demand in combination with a low capacity rate, it gets complex for an AU to still have a complete overview of all flights and the operational consequences. As a result, an effective and fast flight prioritisation becomes difficult and almost impossible.

Therefore, each participating AU needs a FOC graphical user interface to merge UDPP information about flight arrival times and flight delay with their own flight information details to decide more advanced for priority flights.

If the number of affected flights and their delay reaches a level on which the AU is not able to decide for the correct priority of flights in regards of choosing the right flights to optimize the overall operational situation, there should be a prioritisation support in form of an automatized prioritisation proposal, which could be accepted or adapted by the AU.

To do so, each AU who wants to use the benefits of the UDPP concept should define operational criteria, which could be determined/computed for every flight automatically. These criteria should support the AUs to see directly which flights needs to be prioritised in order to have an operational benefit through the UDPP flight prioritisation. Another possibility to use the operational criteria in a more holistic and complex way is to automate the flight prioritisation based on a multi-criteria optimisation.

First with the simulation and later with the shadow mode trial, it was easily possible to improve the overall operational situation and to reduce the delay minutes of the operational important and prioritised flights.

This exercise proved that the UDPP concept can theoretically optimize an airline's flight operations during capacity constraint situations in terms of using multiple criteria without impacting the total ATFCM delay and without affecting other airspace users negatively. This provides AUs with the flexibility to manage their operations according to their preferences (AU flexibility).

Flight prioritisation is there to not only favour one single important flight, but also to optimise/improve the AU network which means decreasing reactive delay and solving proactive night-ban related problems.

Thanks to the NM B2B services, AUs are able to retrieve the necessary data, as it is essential to have all the information available to decide for the right flight prioritization, and as well to send the priority requests with new arrival times to FMP and NM.

Using the UDPP concept with a B2B-connection, UDPP proves its power for a large airline in requiring a very low manual workload and in a more powerful possibility to optimise the arrival sequence than using the NM slot swap functionality.

On the ANSP side, UDPP turns out to be a relevant service for the Airspace Users, as long as the network impact (including as well multiple Airspace Users UDPP actions) is evaluated. The UDPP should be seen as a service of the Network Manager, linked to the CASA-regulation system, so that Airspace Users can directly exchange with NM without having to include the ANSP as an intermediary relay. Once the UDPP will have proven its "inoffensive" impact on the ANSP regulation request as well as amongst the other network stakeholders, Airspace Users should have the benefit to use the UDPP service on their own and the impact shall be transparent on the concerned ANSP flow management position; i.e. flows are regulated as requested (respecting declared capacity and entry loads).

Now that the UDPP mechanism has proven its benefits on a closed environment, the next steps are to assess the system in the operational Network Manager environment, which is imminent future as it will be tackled in the SESAR Wave 2 projects.

M.5 Recommendations

M.5.1Recommendations for industrialization and deployment

Originally, it was planned to have a Very Large Scale Demonstration on the UDPP prototype giving AU the possibility to prioritize their flights. Unfortunately, it was only possible to have a simulation on INNOVE and a shadow mode trial with a one-way connection to NMVP.

Since both the simulation and the shadow mode trial have proved that the UDPP concept provides high added value and flexibility for airspace users, this concept should be further developed to assess the impact on the overall network in order to make it available to AUs in their daily work.

On the ANSP/NM side, the assessment of the UDPP impact on the regulation efficiency (smoothing of traffic with controlled occupancy/entry counts) is a sine qua none criteria.

On the NM side, the assessment of the UDPP equitable treatment among Airspace User shall be proved.

To achieve this, the maturity of the UDPP concept should be gradually increased by using live environment, committing the results of prioritisation to the network and involving all stakeholders.

In order to realize this development progressively, the following different trial phases are recommended:

- A second UDPP shadow mode trial with the actual setup of the UDPP concept and the already used connection to NMVP.
  The difference to the already executed shadow mode trial lies in the use of the UDPP commit function to send the flight prioritisation request to the NMVP system. With this innovation, the impact of flight prioritisation on the European network would be assessable in a validation environment (NMVP).

To conduct the second shadow mode trial, a new UDPP Application Server version is needed, to be able to create UDPP measures with stepwise capacity changes as well as to allow updates of already created measures.

- New trial phase with the test system by NM to analyse the impact on the entire European network and the effects on en-route ATC sectors and hotspots.
- Live Trial: UDPP connection to NM or at least the communication of flight priorities with UDPP arrival times to NM (API messages). Conduction of the trial as a local trial in Zurich with involvement of all affected stakeholder as ECTL/NM, ANSP/FMP (skyguide), airport (Zurich Airport) and AU (SWISS).

The overall recommendation is to have a NM functionality for AUs to give their flight priorities to the NM system (such like UDPP), in order to achieve the optimal distributed delay and therefore best possible impact on their punctuality.

This NM function should be available to all AUs in disregard of the amount of affected flights.

M.5.2 Recommendations on regulation and standardisation initiatives

The UDPP system/service should be fair to all AUs and only shift the delay within each individual airline, or if pre-agreed within an airline group or amongst different airlines.

The UDPP system/service should be accessible to all airspace users.

A network safety assessment of the UDPP system shall also be conducted.