Appendix N Demonstration Exercise EXE-VLD-08-003 (Zürich Improved Arrival Planning and NM Integration) Report

N.1 Summary of the Demonstration Exercise EXE-VLD-08-003 Plan

N.1.1 Exercise description and scope

As stated in the DEMOP, this exercise originates from the previous SESAR Large Scale Demonstration named iStream, conducted at Zurich in 2015-2016 which led to the implementation of the iStream procedure in operations thanks to an automatized process.

At Zurich airport, the iStream concept has been implemented by a procedure delivering Target Times of Arrival at Initial Approach Fixes (IAFs) for all inbound flights within the timeframe [06:00 – 07:00] Local Time (LT).
TTAs are computed relatively to the Estimated Times Over provided by the airborne long-haul flights, their Schedule Time of Arrival (STA) at LSZH and on the Network Manager (NM) estimated flights' profiles for the short and medium haul flights.

The [06:00 – 07:00] LT timeframe has been chosen to improve the traffic situation just after the night ban at LSZH. This process enables sequencing of the aircraft before their entry into Zurich lower airspace in order to optimize flight profiles and avoid any vectoring and holding during this first hour. The iStream project takes also in consideration airspace user's preferences whenever it is possible. Airspace Users having more than one flight in the sequence are able to swap their flights and exchange TTs for specific flights.

A dedicated arrival management tool (also named "iStream") has been developed to compute local TTA and transfer it to the Airlines.

Please bear in mind this **xStream** EXE-VLD-08-003 concerns the **iStream** implementation.

However this local tool missed the link with the Network Manager. The Network Manager did not have knowledge of the Zurich predicted arrival sequence which can affect the predictions computed by NM. Taking into account this weakness, the scope of this exercise was to improve iStream tool with the following additional functionalities (see Figure 1 below):

- Set-up and use B2B uplink channel to send Estimated Time Over (ETOs received from long-hauls outside IFPS zone, in order to update NM ETFMS flight profiles),
- Set-up and use B2B uplink channel to send all Target Time Over (TTOs) from the computed iStream sequence, in order to update ETFMS flight profiles and for NM to have full awareness of our targeted landing sequence and
- Set-up and use B2B download link to retrieve Archive flight data from NM and to establish a post-analysis treatment and presentation for statistics and analysis purposes.

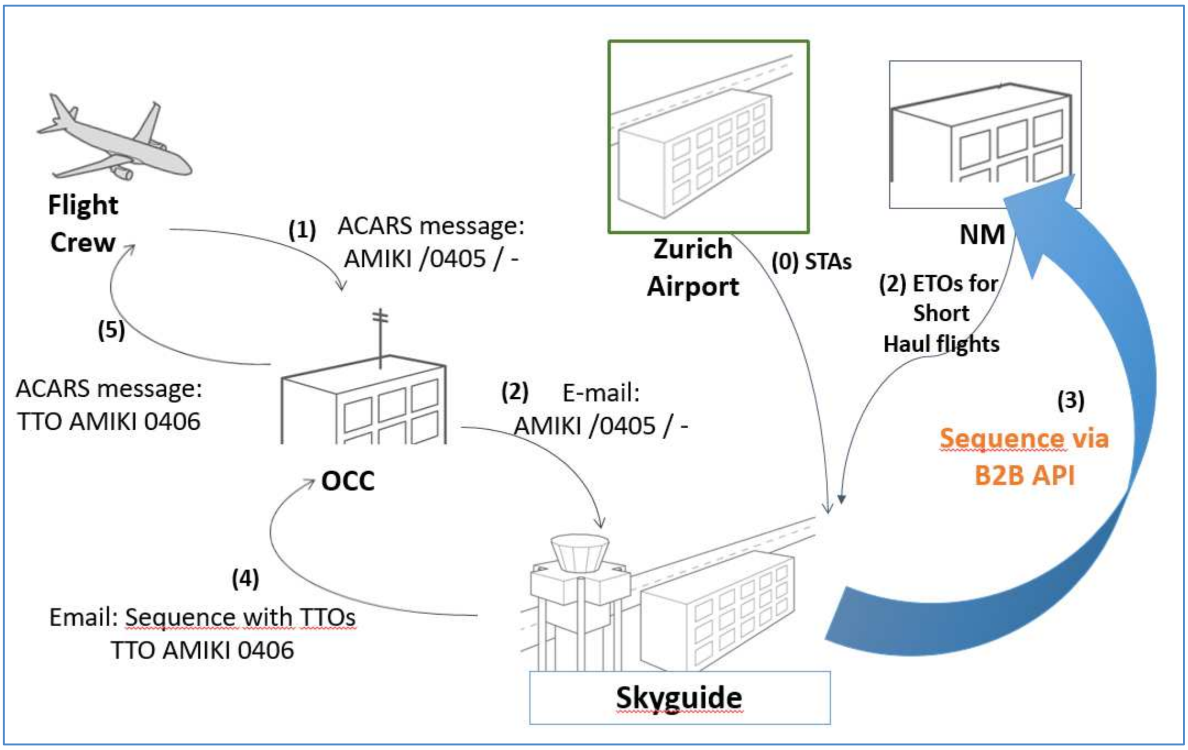


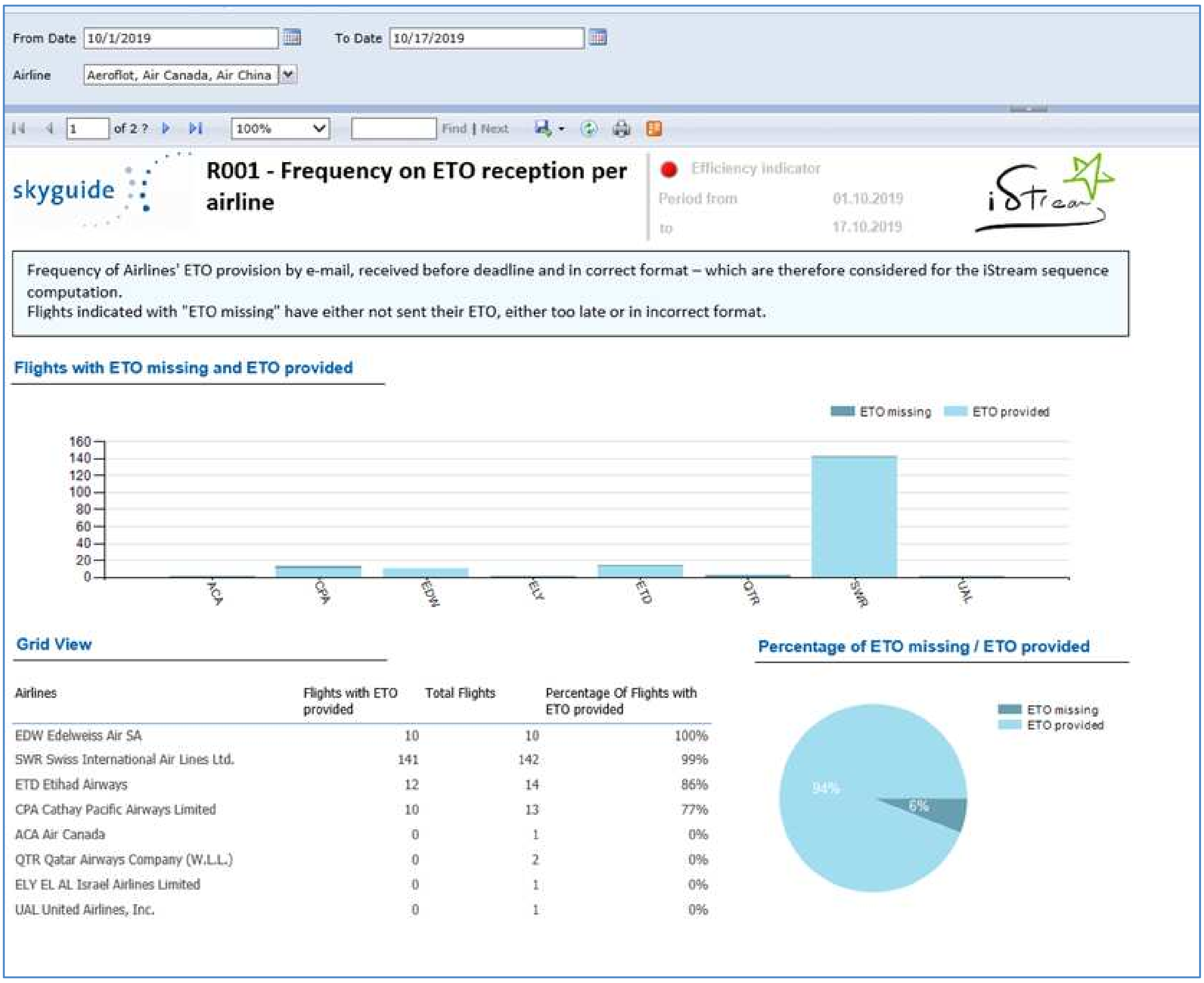
Figure 1: EXE-VLD-08-003: iStream with the new NM B2B API link

In order to enhance flight data accuracy in the ETFMS Profiles, the feasibility to forward the ETOs received from long-hauls (via e-mails) to NM has been trialed. As well, the transfer of the computed iStream sequence, i.e. the TTOs/TTAs computed for the inbound flights was trialed in order to assess the improvement of the arrivals predictability.

Those new functionalities were developed for the NM Release 21 delivered in Q2 2017 offering the new Business-to-Business interface API "Arrival Planning Information".

Furthermore, in order to support the iStream daily process and to identify potential deviations for further improvements to the process, a monitoring tool and post-analysis treatment were required.

The first step consisted in the development of a B2B link to retrieve from the Network Management Archive Flight Data (mainly Actual Time Over the Fix; entry point of the STAR, and Actual Time of Arrival) and establish a process to automatically store the iStream data and compare the planned sequence and the realized one on a daily basis. A dedicated web-page added to the iStream server was developed in order to display the historical results. The process supported the analysis of the Trials and will also support regular analysis which will strive for statistics purposes and for future re-adjustments or enhancements of the procedure.



Airlines	Flights with ETO provided	Total Flights	Percentage Of Flights with ETO provided
EDW Edelweiss Air SA	10	10	100%
SWR Swiss International Air Lines Ltd.	141	142	99%
ETD Etihad Airways	12	14	86%
CPA Cathay Pacific Airways Limited	10	13	77%
ACA Air Canada	0	1	0%
QTR Qatar Airways Company (W.L.L.)	0	2	0%
ELY EL AL Israel Airlines Limited	0	1	0%
UAL United Airlines, Inc.	0	1	0%

Figure 2: EXE-VLD-08-003: Example of web-report for monitoring purposes (test data)

The second step consisted in the development of B2B link based on the new API interface (delivered with NM Release 21.0) in order to upload the iStream locally computed sequence to the Network Manager. Also the possibility to upload Estimated Time Over received from the Airspace Users and computed Target Time Over was trialed, in order to feed the ETFMS profiles available in the CHMI and NOP tools.

A specific Mandatory Cherry Picking regulation was created for the short-haul flights with the objective to convert their TTO into a compatible CTOT and therefore support their adherence to their targeted arrival time.

The iStream system was enhanced to use the STAR entry points as the sequence fixes, instead of the current IAF. This was done in order to ensure consistency with FPLs format, as the last point of the Route field is the STAR entry point. As a consequence, a new Traffic Volume "LSZHISTR" delineated by the STAR entry points (BLM, NEGRA, BERSU, DOPIL, RILAX and GIPOL from GND-245) has been specifically created for the Trials in order to ensure correct computations of CTOTs when TTOs are set on the fixes.

An AIP was published and effective from 19th July 2018 and an information was also distributed by e-mail to all impacted Airspace Users.

Demonstration platform

The PJ25-WP8-EXE#3 platform originates from the iStream Test platform.

iStream designates the operational system put into operations in October 2016 after the successful demonstrations of the SESAR1 iStream LSD project performed in 2015-2016. iStream had an associated test platform used to perform tests and validation of the system before its deployment. After the deployment, the test platform was used for the daily maintenance and evolutions of the system.

For the purpose of the PJ25 WP8-EXE#3, the test platform has been upgraded from the true replica of the operational iStream system to an enhanced iStream system integrating new functionalities serving WP8-EXE#3 goals.

The PJ25 WP8-EXE#3 platform therefore contains the iStream operational functionalities enriched notably with the new B2B API and Mandatory Cherry Picking functionalities.

N.1.2 Summary of Demonstration Exercise EXE-VLD-08-003 Demonstration Objectives and success criteria

See Main Document §4.1.3.3.

N.1.3 Summary of Demonstration Exercise EXE-VLD-08-003 Demonstration scenarios

Reference scenario:

The reference scenario was set to be the current operations as of 15th October 2018 until 15th December 2018 using the original iStream system.

The reason of a reference scenario defined after the Solution scenario is to permit having the same level of quantity and quality of data, by having the same extraction methods and same source for the necessary data and metrics.

Solution scenario:

The Solution scenario is the Trials period, from 10th August 2018 until 30th September 2018.

Note that the Trials period has been divided into two phases:

I. From 10th August until 3rd Sept 2018: only long-haul flights impacted.

   The Estimated Times Over and Targeted Times Over were uplinked to NM using the API Target Time Over service.

II. From 3rd of Sept until 30th of Sept 2018: long + short haul flights impacted with the introduction of the Mandatory Cherry Picking (MCP) regulation.

   MCP regulations were created to enforce the short-haul flights to depart at a certain time ensuring the ability to adhere to the Target Time Over. The Calculated Take Off Times (CTOTs) were computed backwards from the provided Target Time Over the LSZH STAR fix.

Some part of the analysis may refer to the relevant phase only.

N.1.4 Summary of Demonstration Exercise EXE-VLD-08-003 Demonstration Assumptions

The assumptions concerning EXE-VLD-08-003 are provided in the xStream DEMOR main document, in chapter 3.4 "Summary of xStream Demonstration Plan".

N.2 Deviation from the planned activities

The trials were planned to be executed from 10th August to 30th September 2018 daily between 06:00 and 07:00 local time. However the trials could not be conducted on 6 dates, due to not optimal sequence, missing input data or non-availability of data as detailed below. This number of unavailable days do not affect the analysis neither the results of the exercise. In total, 42 trial datasets were recorded and 36 are usable for the analysis.

Reasons for aborting the trial were:

1) sequence could not be optimized as there was more than one flight having TTO exceeding 5 minutes of its ETO,
2) less than 50% of long-haul flights provided their ETO,
3) Non-availability of data.

Note that these reasons are also part of the daily validation of the iStream operational process.

The following tables provide comprehensive information about skipped and usable trial and baseline days.

Date of non-executed trial	Time	Reasoning
2018-08-10	06:00-07:00LT	1)
2018-09-02	06:00-07:00LT	1)
2018-09-15	06:00-07:00LT	2)
2018-09-18	06:00-07:00LT	3)
2018-09-19	06:00-07:00LT	2)
2018-09-21	06:00-07:00LT	1) +2)

Table 1: List of Non-Executed trials with date and reasoning

On the Baseline period, 18 dates were cancelled (17 for reasoning n°1 and 1 for reasoning n°2) and one date where the data was not available.

	Trials	Baseline

Total days available	36	43
Total days unavailable	6	19

Table 2: Summary of available and unavailable trial and baseline days

N.3 Demonstration Exercise EXE-VLD-08-003 Results

N.3.1 Summary of Demonstration Exercise EXE-VLD-08-003 Demonstration Results

The summary table is referred in main document chapter 4.

Please note that qualitative assessment was not performed for all KPAs as the implementation targeted to be transparent of the operations' side. The benefits will be measured solely quantitatively except for KPA Flexibility and ANSP Cost Efficiency, where a quantitative assessment turned out to be not possible.

The following two charts provide the distribution of impacted flights per airline.

Involvement of Airspace Users

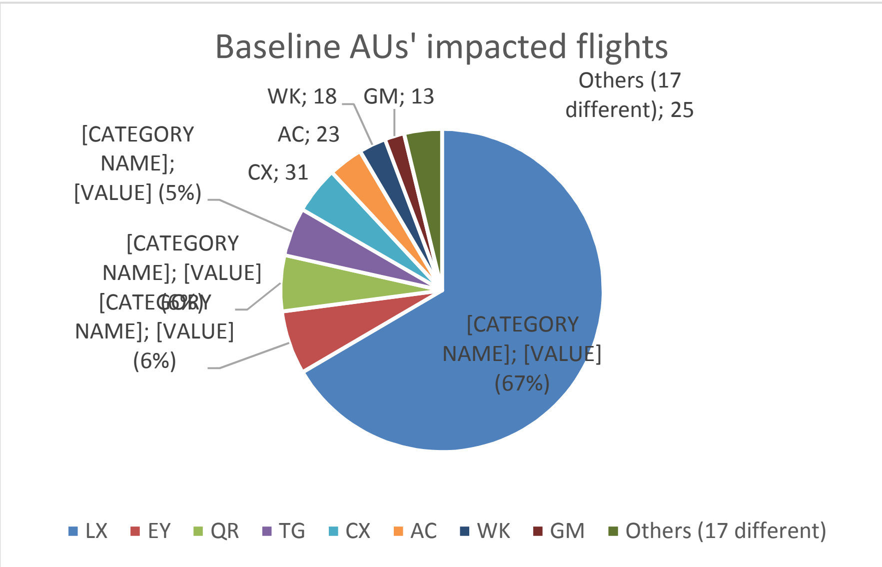


Figure 3: Involved AUs (with number of flights) during the reference period of WP8 EXE#3 Trials

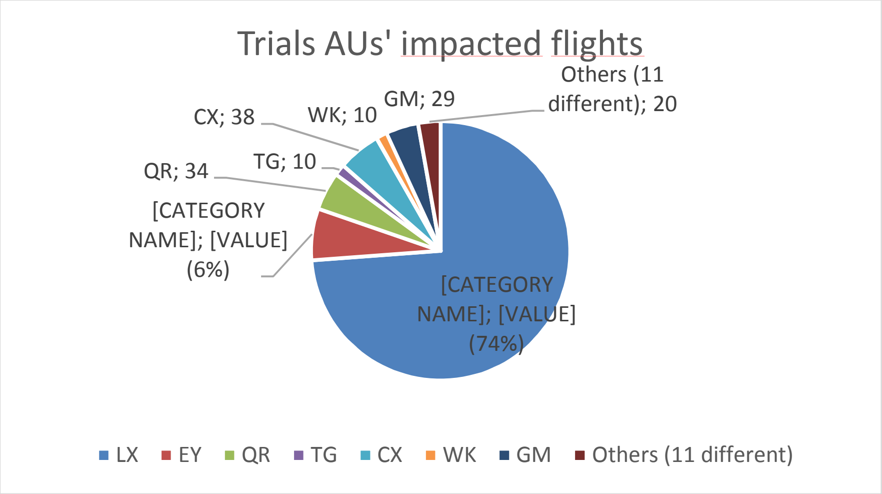


Figure 4: Involved AUs (with number of flights) during WP8 EXE#3 Trials

The iStream timeframe involved a significant number of airlines (18 for Trials and 25 for Baseline), which raised the difficulty to actively involve all participants in the process, knowing that there is no penalty measures for non-participation.

The communication was key for a successful implementation and for all participants to receive the benefits of xStream, as well as to retrieve relevant metrics.

1. Results per KPA

a. KPA Safety

i. Quantitative Assessment

Number of Incident Reports

None incident were caused/reported due to EXE#3 implementation.

ii. Qualitative Assessment

None.

b. KPA Predictability and Punctuality

The assessment within the KPA Predictability and Punctuality is done by quantitative assessment (Metrics 'Time difference actual - planned' and 'Landing Sequence Predictability').

i. Quantitative Assessment

Time difference actual - planned (on RWY and Fix)

ETFMS data were used for this analysis. The results below are based on the calculation of the time difference between estimated time over (ETO) / estimated landing time and actual time over / actual time of arrival. One column in the graphs below represent different points in time at which the ETO / estimated landing time was calculated. For example, the column ∆ 0800 to 0100 in Figure 5 shows the sum over all flights of their time differences between the ETO calculated at 01:00 LT and the ATO, which is already known for all flights at 08:00 LT. Reference and Trial scenarios were applied as described in **Erreur ! Source du renvoi introuvable.**. The two mentioned trial periods are not distinguished here.

The results are presented in the figures below. Figure 5 and Figure 6 show the sum over all flights of their time differences between ETO / estimated landing time, calculated at different points in time. Figure 7 and Figure 8 show the average over all flights of their time differences between ETO / estimated landing time, calculated at different points in time.

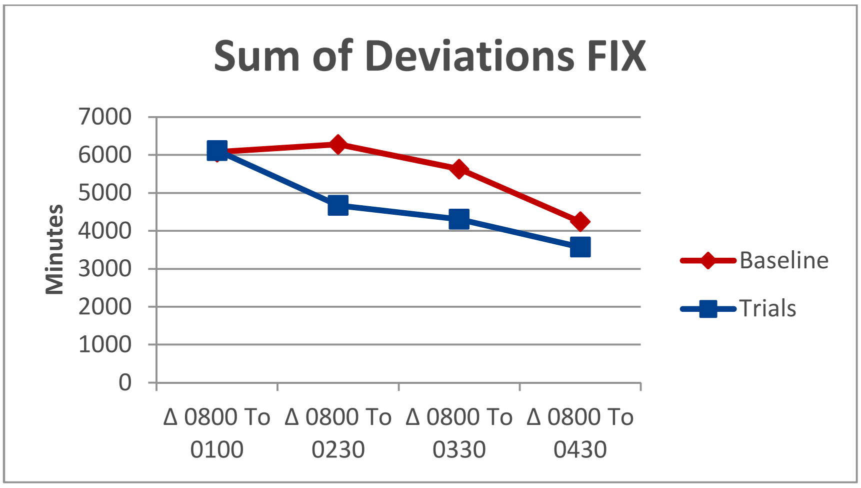


Figure 5: Sum of deviations (time differences ATO - ETO at any approach fix) for all flights of a day

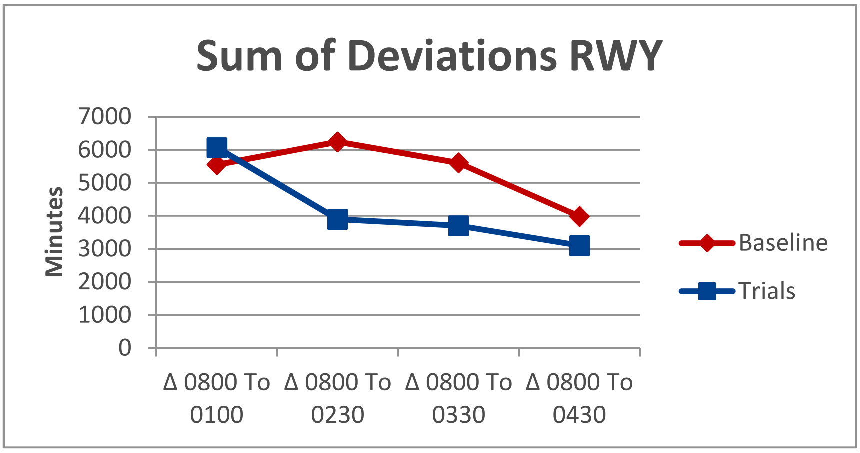


Figure 6: Sum of deviations (time differences ATA - estimated landing time) for all flights of a day

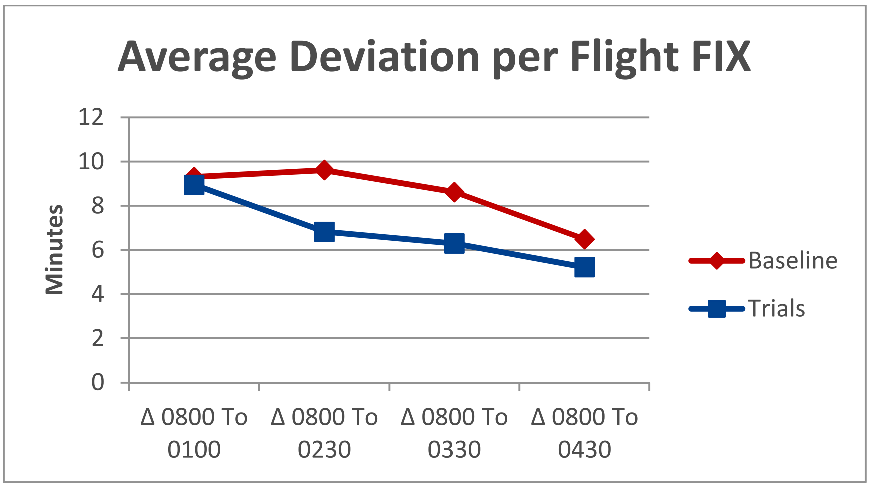


Figure 7: Average of deviations (time differences ATO - ETO at any approach fix) of all flights

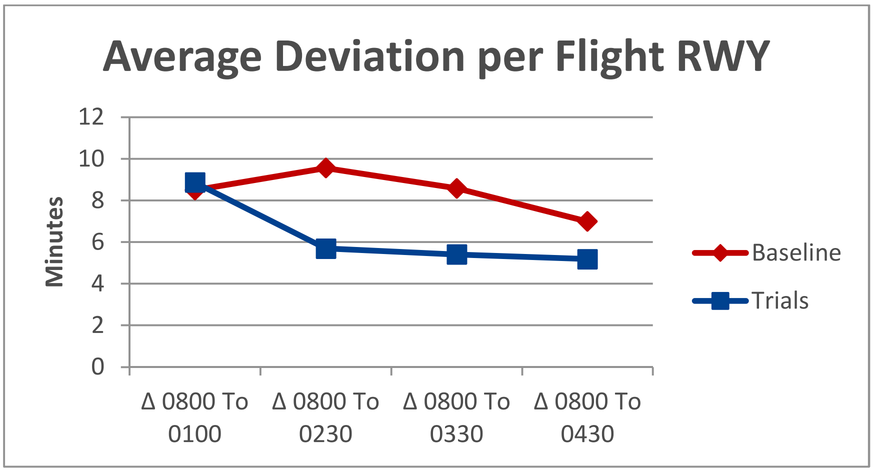


Figure 8: Average of deviations (time differences ATA - estimated landing time) of all flights

For the baseline graphs the expected general trend of less deviations for estimates calculated later in time can well be seen. Basically, the accuracy of the estimates, which is directly connected to predictability and punctuality, does not differ between those calculated at 01:00 LT ad 02:30 LT. There are also only small differences between both and the estimates calculated at 03:30 LT. Estimates calculated at any approach fix seem to be more accurate than estimated landing times, which was also expected.

For the solution graphs the same expected general trend of less deviations for estimates calculated later in time can also be seen. The first most obvious difference is the significant decrease of deviations for estimates calculated at 02:30 LT, compared to those calculated at 01:00 LT. This is due to the fact that the iStream sequence is sent at 01:30 LT to NM and the ETFMS profiles are updated based on the provided TTOs. The second most obvious difference to the baseline graph is that, apart from the first column, the time differences actual-planned are always lower for the trials. The estimates calculated 02:30 LT seem to be almost as accurate as those calculated at 04:30 LT (when all the long-haul flights are in the ECAC area and which profiles are updated thanks to Aircraft Position

Reports). These observations confirm the fact that the API TTOs supported the accuracy improvement of the ETFMS profiles (mainly for long-hauls which are not in ECAC area yet).

These figures show that the tested operational improvement leads to a reduction of the time differences actual - planned and therefore clearly improves predictability.

Landing Sequence Predictability

ETFMS data retrieved from skyguide was used for this analysis; estimated sequences were derived from estimated times over fix / estimated landing times which are valid at 01:00 LT, 02:30 LT, 03:30 LT and 04:30 LT.

Reference and Trial scenarios were applied as described in **Erreur ! Source du renvoi introuvable.**. The two mentioned trial periods are not distinguished here.

The results listed below were calculated with a DLR software application which was especially written for making this assessment within PJ25 WP8 EXE3.

The following figures show the average number of sequence jumps per flight between a certain time in advance (sequence determined at 1:00 local time, at 2:30 local time, at 3:30 local time and at 4:30 local time) and the actual arrival sequence on the runway.

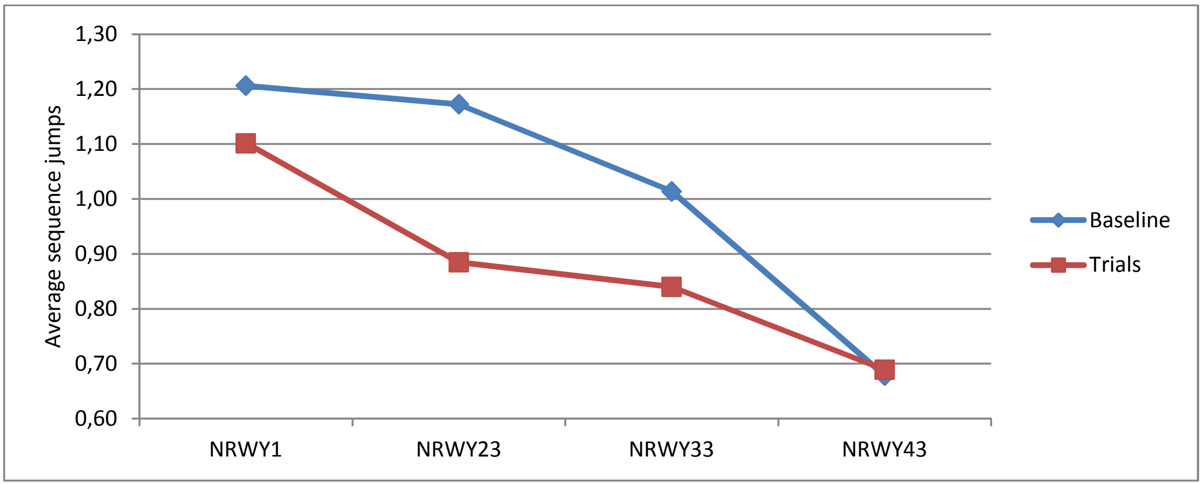


Figure 9: Average number of landing sequence jumps per flight at different points in time (e.g. NRWY1 is sequence determined at 01:00 LT, compared to actual sequence)

Apart from the expected decrease of average sequence jumps with time in baseline and trial configuration it can be clearly seen that the average number of sequence jumps per flight is lower in trial configuration for the landing sequences predicted at 1:00 local time (NRWY1), 2:30 local time (NRWY23) and 3:30 local time (NRWY33). The biggest difference was measured for sequences predicted at 2:30 local time in trial configuration, which is explained with the ETFMS profiles updates thanks to TTOs. In trial configuration, the average number of sequence jumps of the arrival sequence predicted at 2:30 local time (NRWY23) and 3:30 local time (NRWY33) seems to be almost equal.

Sequences predicted at 4:30 show no difference between baseline and trial configuration.

These results show that the tested operational improvement leads to a more stable arrival sequence planning and therefore clearly improves predictability.

Arrival predictability - Landing spacing gaps

The following table summarizes the sum of "landing gaps"; i.e. the actual time difference between 2 arrivals on the RWY threshold, as well as the number of gaps (of 2 min, etc.) per Trials and Baseline periods.

Period 0600 - 0700	Total flights	Avg flights/day	Average gap b/w flights	Nb of gaps						
				2 min	3 min	4 min	5 min	6 min	7 min	> 7 min
Trials	695	14	04:16	57%	21%	5%	3%	2%	3%	9%
Baseline	676	11	03:49	55%	26%	5%	3%	2%	1%	9%

Period 0600 - 0630	Total flights	Avg flights/day	Average gap b/w flights	Nb of gaps						
				2 min	3 min	4 min	5 min	6 min	7 min	> 7 min
Trials	566	11	03:02	62%	22%	4%	2%	2%	3%	6%
Baseline	522	8	02:58	60%	27%	4%	1%	2%	1%	6%

Table 3: Landing gaps for iStream Trials and baseline periods 06:00 – 07:00 LT and 06:00 – 06:30 LT

As the arrival sequence is predicted with 2 minutes gaps between each landing, the first observation is that arrival throughput was slightly optimised during the Trials period, as majority gaps are less than 3 minutes. This optimization is not essential at this timeframe as there is no congestion, but can be clearly beneficial when iStream comes to be used in other busier timeframes.

ETFMS flight profiles evolution measured with the average time difference between Estimated Time Over and Target Time Over at different times every day

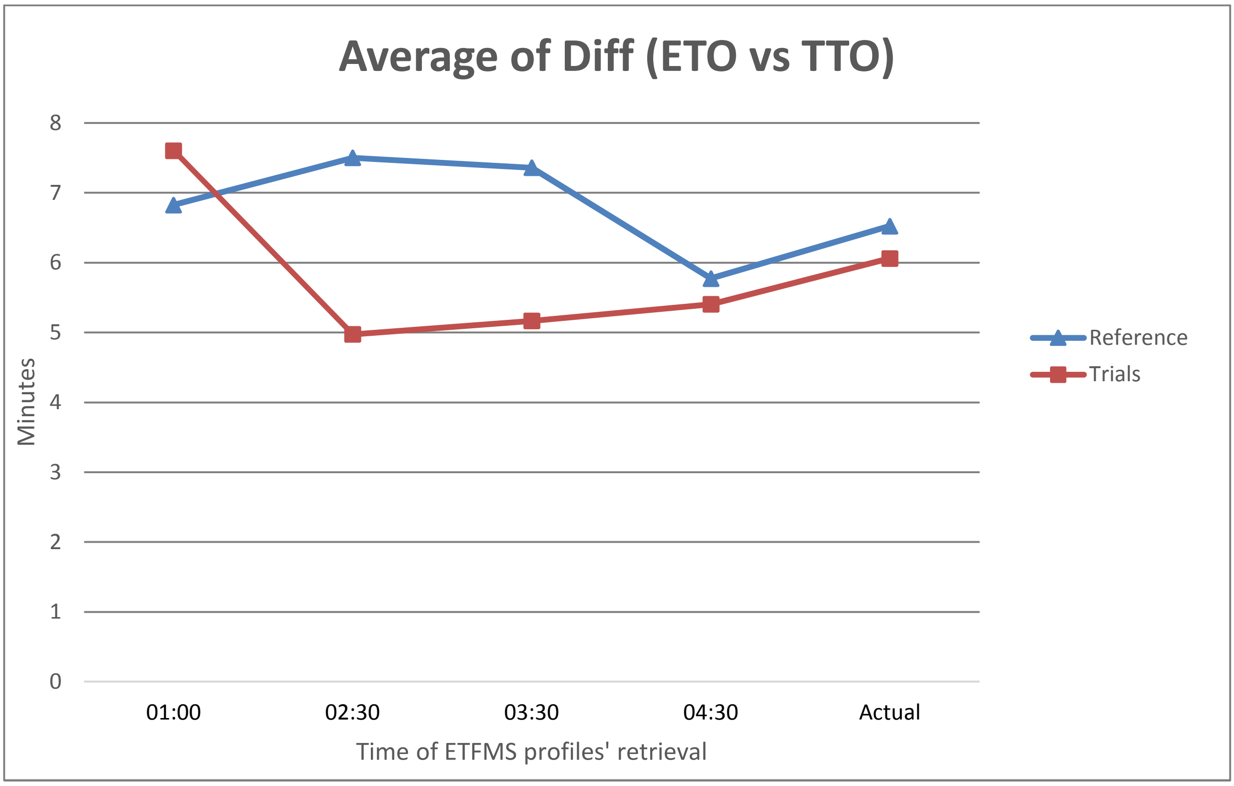


Figure 10: average time difference between Estimated Time Over and Target Time Over at different times every day (ETFMS flight profiles evolution)

The ETFMS flights profiles were retrieved at different times every day (in Local Time):

- 1:00 (before TTOs are sent to NM)
- 2:30 (after TTOs are sent but before long-haul flights enter the IFPS zone)
- 03:30
- 4:30 (after long-haul flights enter the IFPS zone; i.e. profiles are updated thanks to aircraft Correlated Position Reports)
- Actual Times at 08:00 + 12:00 (in case of late arrivals)

The graph shows there is a 2'30 drop; i.e. reduced difference to TTO, when the sequence is sent to NM. This confirms that the ETFMS flights' profiles were effectively updated thanks to the provided iStream sequence.

ii. Qualitative Assessment

The trial proved that timely long haul flight arrival information can be provided, using B2B services, by skyguide to NM well in advance of the flight's arrival time and whilst the flight was outside of the IFPZ. NM was able to process the information and to update the affected flight profiles with the arrival time updates. These updates persisted in the NM data until flight entry into the IFPZ; the arrival times were then either confirmed or superseded by first system activation or correlated position report message information. The improved accuracy of flight profiles resulted in improved demand predictability which benefits all NM stakeholders in their safe handling of these flights within the IFPZ.

Besides the better predictability for NM, it also improves the arrival punctuality and therefore, also improves the airport planning in regards to gate allocation and ground processes.

For SWISS as a hub airline with many passengers connecting from the long haul arrival flights to short haul departure flights, this also has a positive impact on the departure punctuality. As passenger have more time ensured to reach their onward flight.

c. KPA Cost Efficiency

i. Quantitative Assessment

Air Transport Time Efficiency

Track data provided by skyguide was used for this analysis.

Reference and Trial scenarios were applied as described in **Erreur ! Source du renvoi introuvable.**. The two mentioned trial periods are not distinguished here.

Overall, 3420 "passing-over" were considered in the evaluation (see Table 4). Note that one flight can pass over two fixes, as some fixes are part of the same STAR. The quantity of aircraft was in the same magnitude, so the comparability of the two scenarios is ensured.

Waypoint	Baseline	Solution
AMIKI	535	413
BERSU	90	71
BLM	131	152
DOPLI	88	70
GIPOL	198	172
HOC	138	144
KELIP	72	54
NEGRA	515	396
RILAX	118	63
Sum	1885	1535

Table 4: Number of evaluated "passing-over" in the baseline and the solution scenarios

The following figures display the solution-baseline differences in average flight time from passing the appropriate fix until actual landing.

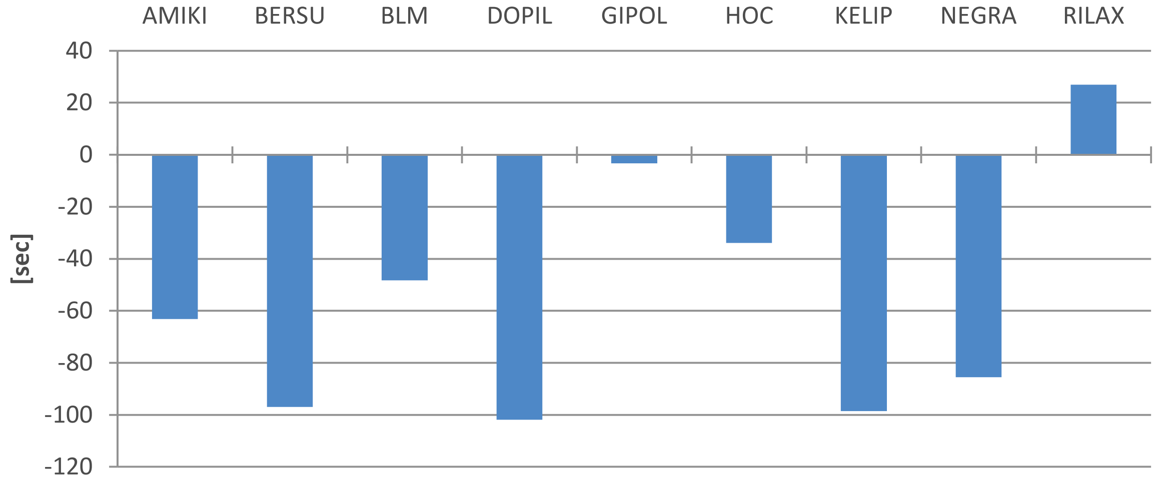


Figure 14: Average flight time differences between baseline and solution scenarios from the selected waypoints to threshold in seconds. Evaluated for all runways.

Comparing the average flight times the aircraft needed from the selected waypoints to the threshold, it should be noted that, except from waypoint RILAX, all average flight times were reduced between 30 and 100 seconds (Figure 14), which points towards a faster approach with less delay absorbing measures inside the TMA. Air Transport Time efficiency seems to be increased.

Air Transport Distance Efficiency

Track data provided by skyguide was used for this analysis.

Reference and Trial scenarios were applied as described in the xStream Demonstration Plan. The two mentioned trial periods are not distinguished here.

The following figures display the solution-baseline-differences in average flight track distance from passing the appropriate fix until actual landing.

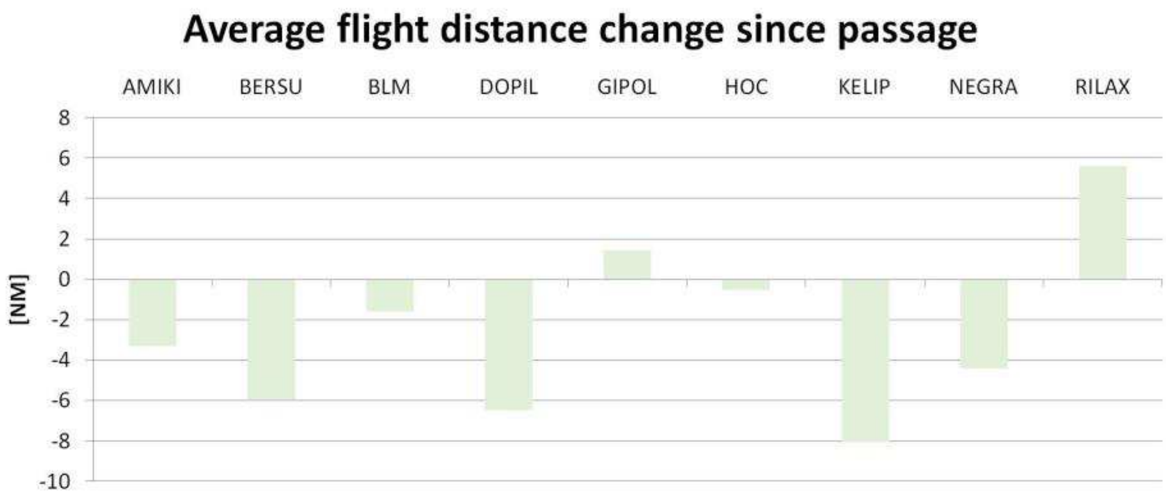


Figure 11: Average flight track distance differences between baseline and solution scenarios from the selected waypoints to threshold in nautical miles. Evaluated for all runways.

Comparing the average flight track distances the aircraft flew from the selected waypoints to the threshold, it should be noted that, except from waypoint RILAX and GIPOL, all average flight track distances were reduced by between 0,4 and 8 nautical miles (Figure 11), which points towards a more direct approach with less vectoring / path stretching manoeuvres inside the TMA. Air Transport Distance efficiency seems to be increased.

Looking only for runway 34 (which is the main RWY used for iStream) and the main waypoints AMIKI, GIPOL and RILAX, the improvements in the solution scenarios become more visible. For this assessment, 879 flight data points with the destination runway 34 recorded during baseline and trial periods were evaluated.

In Figure 12, the average flight time differences between baseline and solution scenarios for the three selected waypoints to threshold 34 in seconds are displayed.

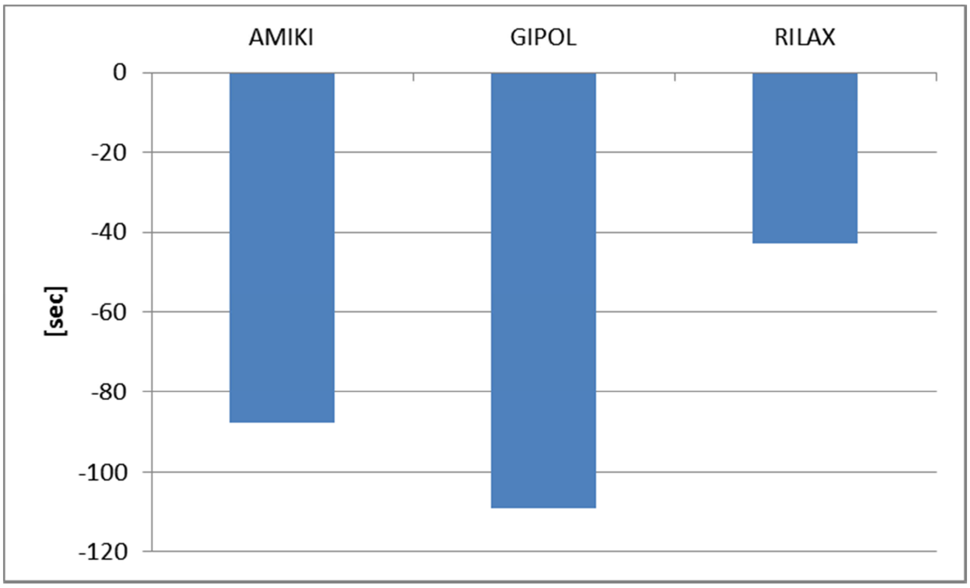


Figure 12: Average flight time differences between baseline and solution scenarios from the three selected waypoints to the threshold of runway 34 in seconds.

In the solution scenario, the flight times in the considered periods were reduced between 40 and 110 seconds in average. In particular, the arriving aircraft overflying AMIKI or GIPOL and landing on runway 34 benefit from the new procedures.

The evaluation of the average flown distances between the three selected waypoints AMIKI, GIPOL, and RILAX and runway 34 show the same positive effects in the solution scenarios (Figure 13).

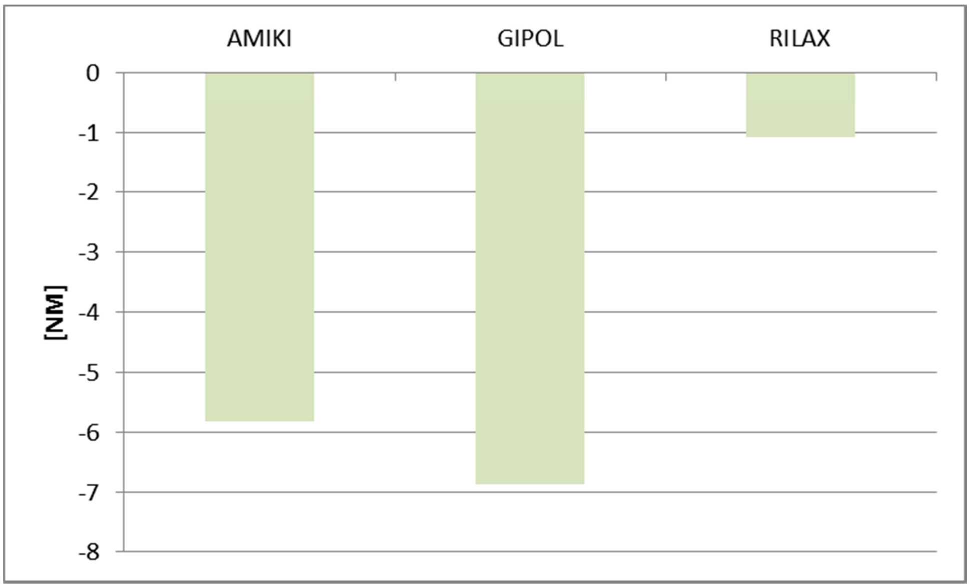


Figure 13: Average flight track distance differences between baseline and solution scenarios from the three selected waypoints to the threshold of runway 34 in nautical miles.

Through the introduction of the new procedures, the average flown distanced between the waypoints and the threshold of runway 34 were reduced between one and nearly seven miles per aircraft. Especially for the waypoints AMIKI and GIPOL, the new procedures achieved a flight distance reduction of nearly six or rather seven nautical miles in average.

ii. Qualitative Assessment

Regarding ANSP Cost Efficiency, Zurich ATCOs received appropriate information during their shifts when they were not in position. Trial days were performed during planned shifts. Therefore EXE-VLD-08-003 implied no extra cost for the ANSP. No additional staff needed to be recruited to conduct the trials.

For the airspace user, this exercise showed an increase of cost efficiency due to optimized arrival routing caused by the better arrival sequence planning. An optimized arrival routing means less vectoring and holdings flown in the TMA Area, which helps to reduce the fuel burn and environmental impact of each flight.

d. KPA Capacity

i. Quantitative Assessment

Total ATFCM delay

In normal operations there is no capacity arrival regulation at the iStream timeframe (06:00 – 07:00 LT). The traffic demand does not exceed the capacity.

However for the aim of the Trials to enhance the short-hauls adherence to the iStream sequence, we intentionally created Mandatory Cherry Picking regulations and therefore created some delays. The Cherry Picking regulations targeted only the few short-hauls included in the iStream sequence and was not expected to create major delays.

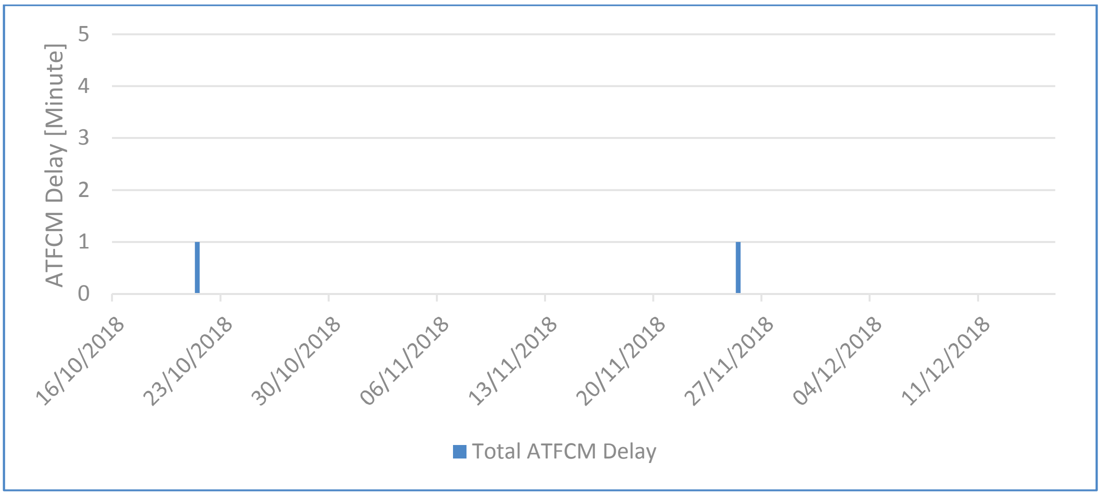


Figure 14: Total ATFCM delay for the baseline timeframe

There were a total of 2 minutes of ATFCM delay, due to LSZH Arrival regulation, in the baseline timeframe (see Figure 15 and Table 5).

Total ATFCM delay for Baseline period	**2**	
Flights regulated	3	3 LSZH ARR Regulations
Flights regulated/delay = 0	1	
Flights regulated/delay > 0	2	
Flights delayed > 15	0	

Table 6: Total ATFCM delay and number of regulated and delayed flights for the Baseline period

Of course the ATFCM delay during the Baseline period is almost null, as there is no capacity issue at this timeframe.

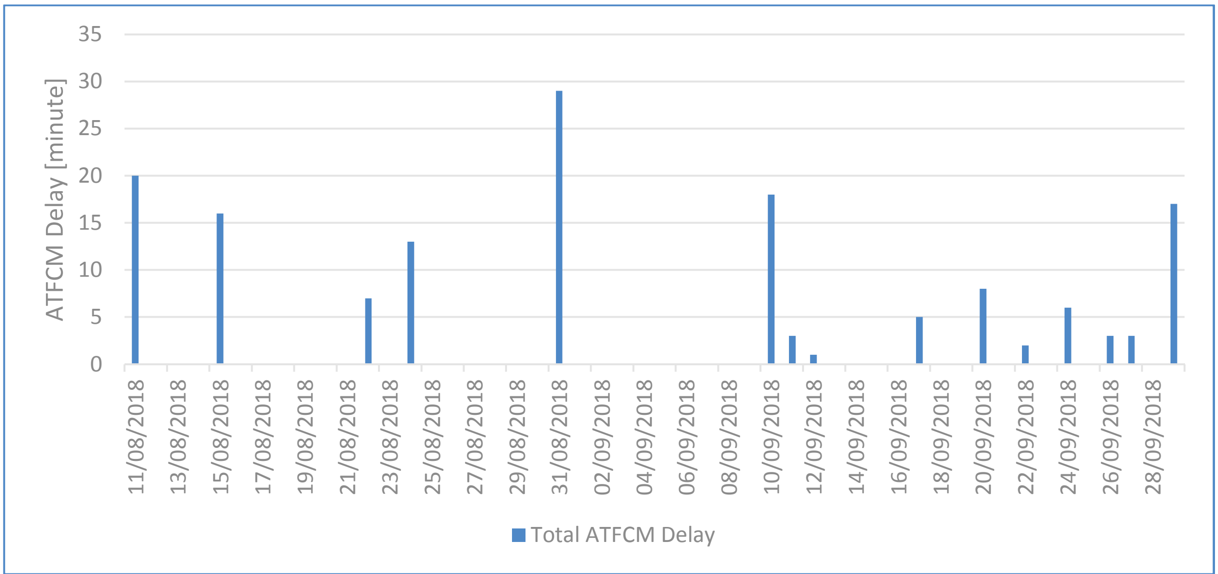


Figure 15: Total ATFCM delay for the solution timeframe

	Baseline	Solution
Days with delay	2	15
Share of days with ATFCM delay [%]	5%	35%

Table 7: Number of days with ATFCM delay (rounded values)

	Baseline	Solution
Average ATFCM delay per day [min]	0.05	4.2
Average ATFCM delay per flight (min)	0.003	0.2

Table 8: Average total ATFCM delay for all flights in the baseline and the solution timeframe

Number of regulated flights by a Zurich arrival regulation

The number of regulated flights represents the part of flights caught in a Zurich arrival regulation. Looking at the numbers of regulated flights, the baseline timeframe shows only two days with one aircraft with a regulation during the one-hour trial running time (Figure 16). In relation to the 43 days period, this equates to nearly 5% of the days.

During the trials timeframe and the introduction of the MCP, there were a total of 15 days with regulated flights which represents 35% of the trial period.

	Baseline	Solution
Number of LSZH ARR regulated flights	2	50

Table 9: Number of regulated flights by a LSZHARR regulation during the baseline and the solution timeframe.

Number of flights delayed by more than 15min (all regulations)

During the solution timeframe 3 days were concerned by delayed flights with more than fifteen minutes delay, with one flight per day. However, none of them is due to a LSZH MCP regulation. The peak of delay on the 31st of August is due to a Cyprus en-route regulation (29 minutes). The delays are otherwise scattered along the solution timeframe (Figure 17).

ATFCM situation

Please find below 3 tables resuming:

- the overall ATFCM situation for the Trials period,
- the ATCFM situation due to MCP regulations and
- the ATFCM situation non-related to MCP regulations.

Total ATFCM delay for Trials period (ALL regulations)	151 min	
Flights regulated	57	
Flights regulated/delay = 0	38	67%
Flights regulated/delay > 0	19	33%
Flights delayed > 15	3	

Table 10: Total ATFCM delay due to all regulations and number of regulated and delayed flights for the Trials period

Total ATFCM delay for Trials period due to MCP	66 min	
Flights MCP-regulated	50	
Flights regulated/delay = 0	36	72%
Flights regulated/delay > 0	14	28%

Flights delayed > 15	0	

Table 11: Total ATFCM delay due to MCP regulations and number of regulated and delayed flights for the Trials period

Total ATFCM delay for Trials period non-related to MCP	85 min
Flights regulated	7
Flights regulated/delay = 0	2
Flights regulated/delay > 0	5
Flights delayed > 15	3

Table 12: Total ATFCM delay due to Non-MCP regulations and number of regulated and delayed flights for the Trials period

The ATFCM situation is not to be assessed on its own and has to be evaluated in the entirety of the trials with the other metrics, specifically the predictability. As the iStream timeframe does not present ay congestion nor capacity issues, the Solution scenario voluntarily induced ATFCM delay to enforce the CTOT/TTOs of the short-hauls, and therefore increase their adherence to the predicted sequence. That is the reason why the created ATFCM delay shall only be assessed in comparison of the increased arrival predictability to determine the usefulness of the scenario.

In any case, it can be observed that majority of MCP (72%) attributed slots resulted in a 0-delay regulation; which demonstrates that the MCP effectively played its role; i.e. enforced the ETOTs of the short hauls.

Also we can see that the major part of ATFCM delay during the Trials period were not due to iStream MCP regulations (66 minutes for MCP versus 85 minutes for other regulations).

Note also that within these 85 minutes, only 20 minutes were due to a LSZH arrival regulation, all others are due to external en-route regulations (mainly Cyprus and Austria).

ii. Qualitative Assessment

None.

e. KPA Flexibility

i. Quantitative Assessment

Performed / received requests ratio

A quantitative assessment of the performed and received requests is not possible due to the complexity and dynamic arrival steering every morning done by the Operations Controller at SWISS.

ii. Qualitative Assessment

In the course of the daily experience of an SWISS Operational Controller, three to four swaps in the landing sequence will be done during the iStream process at night, in order to optimize the AU passenger connections and therefore grant more time for flights with many transfer passengers to successfully connect.

During the flight planning phase, the day before arrival, the SWISS flight dispatcher does already one to two swaps in the arrival planning sequence based on the calculated flight times and number of passenger connections. This strategic phase already allows flexibility and an early information to the cockpit crew even before departure.

2. Results impacting regulation and standardisation initiatives

Regarding a further implementation of the API service, the following should be taken into account to improve the usability of the service:

- The API service should be available
- The API “Slot Zone” should be widened (i.e. [-10;+10]);
- The latest & earliest TTA possible to be given to a flight should be available.

N.3.2 Analysis of Exercises Results per Demonstration objective

1. EXE-VLD-08-003 OBJ-VLD-01-001 Results

This objective was to show that xStream operational improvements are respecting the current level of safety in air traffic management.

The corresponding success criterion is fulfilled when the safe management of traffic by ATC is not compromised and new procedures did not cause any incidents.

This objective was covered by a quantitative assessment ('number of incident reports').

As no incidents were reported during the trials the objective can be considered as fulfilled.

2. EXE-VLD-08-003 OBJ-VLD-02-001 Results

This objective was to show that xStream operational improvements provide a better predictability and punctuality of air traffic in TMA / terminal sectors.

The corresponding success criterion is fulfilled when differences between planned / predicted and actual traffic flow at prominent points or at the runway are reduced.

This objective was covered by a quantitative assessment of the 'time difference actual - planned' as well as the 'landing sequence predictability', 'Arrival predictability - landing spacing gaps' and 'Time difference between ETO and TTO'.

As written down in N.3.11.b.i, the number of average sequence jumps per flight is reduced in trial configuration compared to the baseline for predicted sequences. Therefore in trial configuration the planned arrival sequence is more stable while the most improvement has been achieved for sequences predicted at 2:30 local time thanks to the uplinked iStream TTOs to NM. All four indicators pointed out that the overall predictability and punctuality has been clearly improved.

As a conclusion, success criterion CRT-VLD-02-001 can be seen as fulfilled and objective OBJ-VLD-02-001 can be seen as fulfilled.

3. EXE-VLD-08-003 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.

This objective was covered by a quantitative assessment of 'air transport time efficiency' as well as the 'air transport distance efficiency'.

Both indicators show a reduction of the time resp. distance flown inside the TMA, therefore a higher flight efficiency was measured between the used STAR fixes and touchdown during the trial days.

This exercise therefore showed an increase of cost efficiency, also due to optimized arrival routing caused by the better arrival sequence planning. An optimized arrival routing means less vectoring and holdings flown in the TMA Area, this furthermore helps to reduce the fuel burn and environmental impact of each flight.

As a conclusion, success criterion CRT-VLD-04-001 can be seen as fulfilled and objective OBJ-VLD-04-001 can be seen as fulfilled.

4. EXE-VLD-08-003 OBJ-VLD-04-002 Results

This objective was to show that xStream operational improvements are feasible while maintaining current level of ANSP cost efficiency.

The corresponding success criterion is fulfilled when ANSP costs are maintained.

The objective was covered by qualitative feedback as a quantitative assessment turned out to be not possible.

Regarding ANSP Cost Efficiency, Zurich ATCOs received appropriate information during their shifts when they were not in position. Trial days were performed during planned shifts. Therefore EXE-VLD-08-003 implied no extra cost for the ANSP. No additional staff needed to be recruited to conduct the trials.

As a conclusion, success criterion CRT-VLD-04-002 can be seen as fulfilled and objective OBJ-VLD-04-002 can be seen as fulfilled.

5. EXE-VLD-08-003 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.

However this particular objective does not apply as it for the EXE-VLD-08-003. ATFCM delay was additionally created in order to enhance the short-haul predictability and therefore adherence to the targeted sequence. The results demonstrated that the ATFCM measures were beneficial to predictability, and therefore the overall success of the iStream process. The added ATFCM delay (66 minutes over one month period) was marginal and main impact of the ATFCM measure was to enforce the planned take off time of the short hauls (more than 70% of short-haul flights had a zero minute delay), which led to enhance the predictability.

6. EXE-VLD-08-003 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.

The objective was covered by qualitative feedback as a quantitative assessment turned out to be not possible.

According to the qualitative statements, the operational improvements lead to a more flexible management of arriving flights by aircraft operators / airspace users.

As a conclusion, success criterion CRT-VLD-06-001 can be seen as fulfilled and objective OBJ-VLD-06-001 can be seen as fulfilled.

N.3.3 Unexpected Behaviours/Results

N.3.4 Confidence in the Demonstration Results

1. Level of significance/limitations of Demonstration Exercise Results

The level of Airspace Users' participation in the live trial was fully reached and was key for a successful implementation and therefore to retrieve relevant metrics. The environment conditions in nominal operations and the number of usable datasets can provide sufficient confidence into the trials' data for the KPA measurement and assessment.

Some general limitations with impact on the level of significance could be identified.

Type of Assessment	Description of Limitation	Impact on level of significance
Quantitative and Qualitative	Meteorology: The assessed data were recorded during different seasons of a year, which means, that main meteorological constraints like wind speeds and directions may not be completely comparable.	This may have an influence on the flight times and distances during the approach phases. Therefore, positive and negative effects of operations could be underrated or overrated in the assessment.
	Data availability: The number of evaluable flights in baseline and solution scenarios are not strictly the same.	The validity of some baseline-solution comparisons may be reduced.

2. Quality of Demonstration Exercise Results

The source of data for both the Demonstration period and Baseline period are the NM EFTMS and skyguide track radar data. Those sources are reliable and therefore the data quality can be assessed accurate. DLR analysis tools are also proven to be reliable as most of them were and are regularly used for all kinds of simulated or live air traffic validations, and therefore full confidence can be given into the results.

However what we can highlight about the quality of data is the accuracy of the long-haul flights (outside IFPZ zone) Estimated Time Over provided by the Airspace Users compared with the times retrieved from the Network Manager.

As illustrated in the figure below (taken from the post-ops analysis tool), the deviations of the actual times compared to the targeted ones are much lower when the ETOs have been provided by the Airspace Users, which infers that the targeted times were most easily reachable.

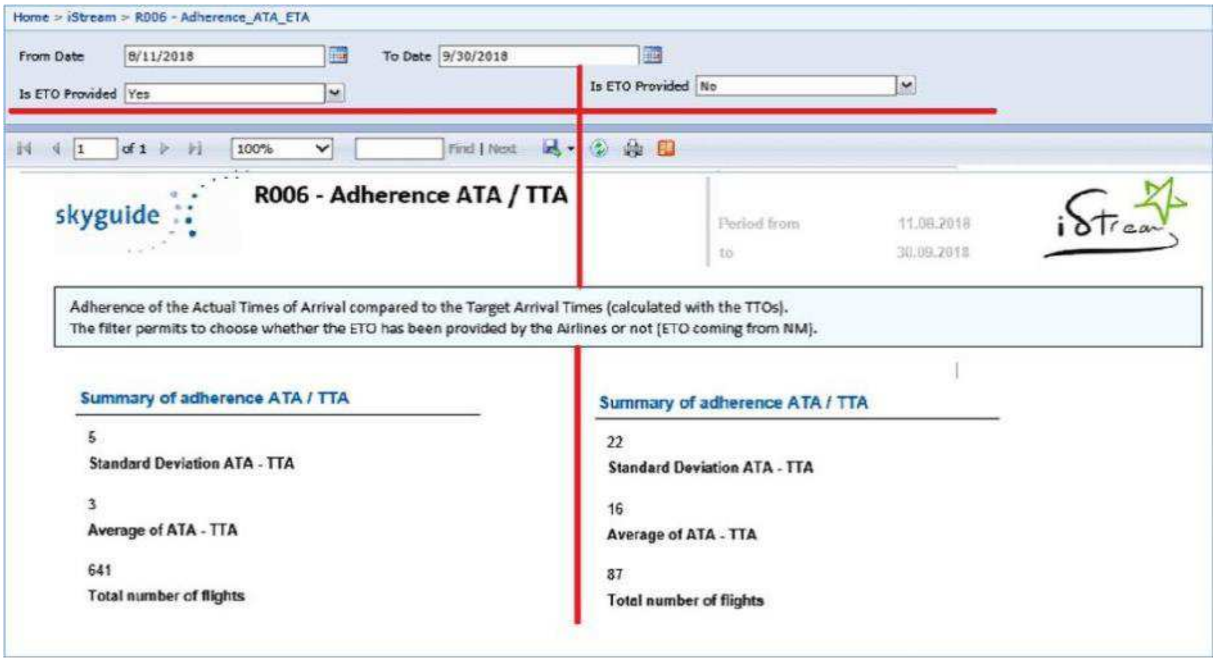


Figure 18: Comparison of ATA/TTA deviation with ETO provided by Airlines vs. ETO retrieved from NM during Trials period

3. Significance of Demonstration Exercises Results

The results fully reach the significance level to complete and assess the Demonstration objective and support the directions of improvement of the iStream process. However, speaking of after-xStream life, the trials did not last long enough to issue in a sufficient amount of results in order to decide for a future implementation. Furthermore the Trials were conducted solely in Summer season, though it is the highest traffic season, we would need to analyse the Winter as well.

N.4 Conclusions

The exercise showed an improved arrival predictability for both long and short haul flights. It also proved that a greater adherence of short haul flights towards the arrival landing sequence is possible. Particularly, the scheduled departure times at the outstations were more often kept instead of taking-off too early and therefore arriving too early at the Zurich airport and disturbing other sequenced arrival flights, mostly long haul flights.

Overall the exercise improved the ETFMS flight profiles accuracy. The uplinked API TTOs updated the ETFMS profiles and improved their accuracy. The ETOs provided by AUs/Flight Crews are much more accurate than NM profiles, as described in N.3.2.

The exercise has proven that Airspace User operations can be improved. By taking into account Airspace Users' priorities, passenger connections can be ensured and offers a more reliable operations. Integrating Airspace Users in the loop of arrival sequencing is valuable for all stakeholders.

During the Mandatory Cherry Picking Trial, short haul flights received in most cases an on-time slot. Discrepancies in flight times were found between planned departure and arrival routing versus the actual flown departure and arrival routing due to the NM used profile. This issue needs to be taken into account for future developments.

Additionally, the newly monitoring tool enables regular statistical reports. These reports supports the communication towards the involved Airspace Users with providing accurate iStream figures and improves the global iStream process.

N.5 Recommendations

N.5.1 Recommendations for industrialization and deployment

As written in the conclusion, the exercise has shown a better accuracy of the ETFMS profile through the enhancement of the iStream process including NM. In the future, the NM ETFMS profiles should aim for a higher accuracy, in particular through Airspace Users providing Aircraft Position Reports, the extended Flight Plan to NM and the use of the NM B2B API service to send timing information for long-haul flights outside IFPZ.

As the trial phase with the Mandatory Cherry Picking Process was very short, a longer trial phase would be necessary to gain more results proving the positive impact on the arrival sequencing which is balancing the ATCFM delay created. However the use of API was beneficial to allow ANSP to provide Target Times of Arrival for specific flight, and therefore the B2B API service should be made available in NM OPS systems.

The usability of the NM B2B2 API service would be enhanced provided:

- The “Slot Zone” is widened (i.e. minimum [-10 mins; +10 mins])
- The latest & earliest possible TTA to be given to a flight is available.

N.5.2 Recommendations on regulation and standardisation initiatives

Not applicable.