Appendix E   Presentation of the xStream methodology for Performance assessment

E.1 Purpose of this document

The purpose of this appendix is to explain the strategy and methods applied in the performance assessment of the exercises in the xStream project. It explains how to ensure that all actors involved in different exercises had a common view about the metrics and the methods used for performance assessment in PJ25.

E.2 Methodology for Performance Assessment in PJ25 xStream

The methodology used for performance assessment in PJ25 xStream is in compliance with the SESAR requirements and follows the SESAR 2020 Performance Driven Approach, the framework of metrics (Key Performance Areas/KPAs, Key Performance Indicators/KPIs, etc.) and is tailored to the individual solutions and exercise objectives.

All demonstration objectives of PJ25 are strongly linked with corresponding KPAs, e.g. OBJ-VLD-01-001 is linked to KPA 'Safety'. Consequentially, also the used (key) performance indicators (KPIs/PIs) are linked on one hand to the KPAs according to the framework, on the other hand to the applicable demonstration objectives (see figure 1).
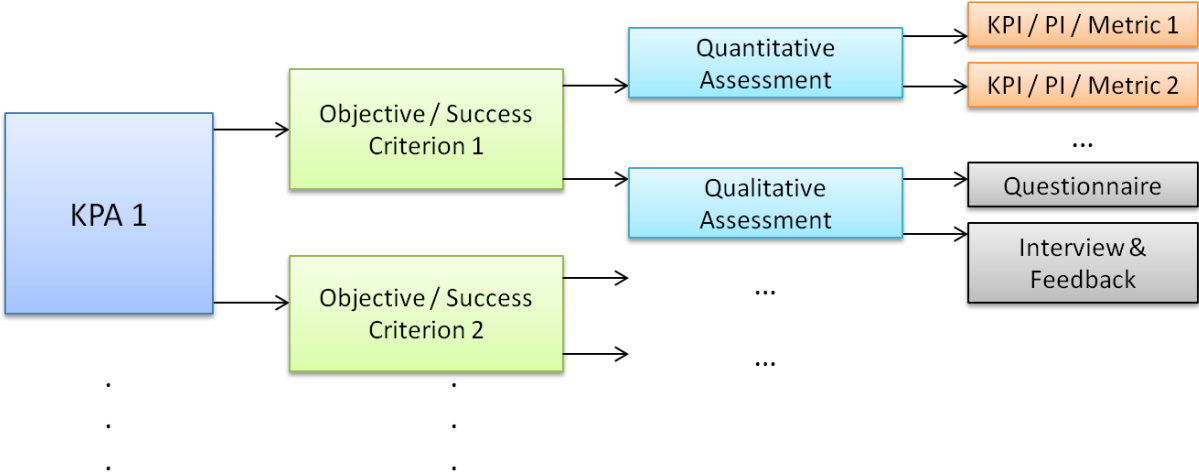

Figure 1: Relation between KPA, Demonstration objectives, Success Criteria, Qualitative and Quantitative assessment as well as KPIs / PIs / metrics

Precise quantitative validation targets for individual performance indicators were not defined as the goal was either to measure any benefit if possible (e.g. fuel consumption); or to confirm that there is no negative impact (e.g. ATC capacity is not decreased, workload is not increased, ATFCM delay is not increased etc.). Further, it could not be guaranteed from the beginning of the project that the benefit is measureable in live trials with the given accuracy of available assessment methods, considering the natural volatility of daily air traffic.

E.2.1 Quantitative and Qualitative Assessment

Every defined demonstration objective shall be answered by applying either a quantitative assessment and/or a qualitative assessment, using appropriate performance indicators or scientific qualitative assessment methods. In more detail,

1. The quantitative assessment is based on the core idea of a baseline-solution comparison of the performance indicators by measuring them for the flight trials as well as for the defined baseline traffic sample. The difference between both per indicator quantifies the benefit brought by the operational improvement.

2. The qualitative assessment relies on the feedback of the staff involved in the flight trials, which is collected with scientific methods such as standardized questionnaires or interview techniques. As far as possible, this assessment shall also follow the idea of comparing 'baseline'- with 'solution'-scenario.

E.2.2 Daily Volatility and Comparability Issues

As the demonstration exercises in PJ25 xStream are performed as live trials, a variety of influencing factors like weather effects, daily circumstances and changing ATC personnel conditions may distort the measured results of performance indicators. In strong contrast to simulations, two live trial runs performed on two different days may be incomparable as the listed influencing factors cannot be kept constant. It must be understood that in experimental terms a live trial takes place in a variable situation, so experiments and data collections are often not easily repeatable or comparable with pre-trial operations. To reduce this risk, the following measures were considered whenever possible:

- all trial runs belonging to the same exercise shall be performed during the same daytimes / peaks,

- the number of trial runs per exercise shall be as large as possible,

- whenever suitable, the data shall be checked for comparability by using the method defined in section E.3.

Summarizing, for live trials, real air traffic in defined daytime periods shall be selected to collect the data needed for the performance assessment. To achieve results of statistical significance, several trial sessions shall be conducted within one exercise. In detail, the baseline scenario shall have the same initial and frame conditions as the solution scenario. Just the concept, technology or working condition subject to the assessment shall not (or at least not fully) be used / working / present in the baseline scenario.

E.2.3 Selection of Reference Data

In order to select reference data which is suitable to serve as a baseline for live trials, the following principles are observed:

- In order to avoid distortions caused by seasonal flight plan changes or the long-term growth of air traffic, the used reference periods shall be timely as close as possible to the corresponding trial periods.

- The total number of days serving as baseline shall be similar to the total number of trial days per exercise.

- Specific weekdays (e.g. Saturday or Sunday), that were excluded during the trial period, shall also be excluded for the baseline period.

- The reference data shall be checked for comparability against the trial data by using the method defined in section E.3.

E.3 Method for Comparability Checks

For PJ25 xStream demonstration exercises, the following standardized method for performing comparability checks shall be applied whenever possible (e.g. all needed data is available) and needed (e.g. whenever a quantitative measurement involving a baseline-solution comparison is applied).

Due to the high variability of live air traffic it is expected that a full comparability is impossible to be achieved, therefore a minimum level of coincidence shall be ensured between two datasets by using the procedure described below. This procedure can be understood as a 'checklist', containing known influencing factors with the potential to distort performance assessment results if they are not kept constant. If any of those items is not equal or operationally comparable, the whole dataset shall be considered incomparable and it shall be withdrawn from the result analysis.

The individual items to be checked are:

a. Runway Configuration(s)

The runway(s) in use of the considered XMAN airport(s) as well as all neighbouring airports (in case there is an effect on the considered XMAN airport(s)) shall be the same in all trial sessions within one exercise.

The runway configuration(s) shall not be changed during the trial sessions except on a scheduled / regular basis. Then this basis must be identical in all solution and baseline sessions.

The following data / methods can be used to do this check (beside others):
  - Daily logs or
  - Automatic tools analysing radar data and extracting / approach and departure directions or
  - Involved controllers / supervisors fill out a simple questionnaire covering frame conditions.

b. Local Weather

The local weather at considered XMAN airport(s) shall imply the same operational restrictions / conditions in all trial sessions within one exercise. In particular, the local weather situation shall not cause circumstances making the use of adapted procedures or guidance methods necessary (on ground or for airborne traffic).

In detail, special attention shall be given to:

  - Strong crosswind components, turbulences and wind gusts,
  - Poor visibility, low ceiling, cat II / III operations,
  - Severe weather like cumulonimbus, thunderstorms, hail or heavy precipitation,

- Conditions which may cause icing.

The following data / methods can be used to do this check:
- METAR / SPECI data during trial sessions.

c. Area Weather

The area weather inside of considered XMAN horizon(s) shall imply the same operational restrictions / conditions in all trial sessions within one exercise. In particular, the area weather situation shall not cause circumstances making the use of adapted procedures or guidance methods necessary.

In detail, special attention shall be given to:

- Strong winds (to exclude a significant effect on the traffic flow),
- Severe weather like cumulonimbus, thunderstorms, hail or heavy precipitation,
- Conditions which may cause severe icing.

The following data / methods can be used to do this check:
- SIGMET / AIRMET reports during trial sessions or
- Involved controllers / supervisors fill out a simple questionnaire covering frame conditions.

d. Local Conditions

The local circumstances shall imply the same operational restrictions / conditions in all trial sessions within one exercise. In particular, no circumstances requiring the use of adapted procedures or guidance methods shall be present.

In detail, special attention shall be given to:

- Closure of runways / parts of the aerodrome / restricted aerodrome capacity,
- Failure of essential navigation aids or aerodrome equipment with significant impact on operational procedures (ILS, GNSS),
- Airspace restrictions with significant impact on operational procedures.

The following data / methods can be used to do this check:

- Daily logs of the trial sessions,
- Effective local NOTAMs during trial sessions or
- Involved controllers / supervisors fill out a simple questionnaire covering frame conditions.

e. Area Conditions

The circumstances within the considered XMAN horizon(s) shall imply the same operational restrictions / conditions in all trial sessions within one exercise. In particular, no circumstances requiring the use of adapted procedures or guidance methods shall be present.

In detail, special attention shall be given to:

- Failure of essential navigation aids with significant impact on operational procedures (VOR, GNSS),
- Non-availability of commonly used routings within a sector,
- Airspace restrictions with significant impact on operational procedures or airspace capacity.

The following data / methods can be used to do this check:
- Daily logs,
- Airspace Use Plan / Updated Airspace Use Plan,
- Effective FIR / UIR NOTAMs during trial sessions or
- Involved controllers / supervisors fill out a simple questionnaire covering frame conditions.

f. ATC Status

The ATC units responsible for providing ATC service in the sectors within the considered XMAN horizons shall have the same operational status in all trial sessions within one exercise. In particular, no circumstances requiring the use of adapted procedures or guidance methods shall be present.

In detail, special attention shall be given to:
- Failure of essential ATC equipment such as air-ground / ground-ground communication / coordination systems, flight planning systems or controller assistance systems,
- Use of backup equipment and contingency procedures,
- Sector configuration / combination,
- ATC capacity,
- Staffing / Strikes.

The following data / methods can be used to do this check:
- Daily logs,
- Involved controllers / supervisors fill out a simple questionnaire covering frame conditions.

g. Traffic Constellation

The traffic constellation (aircraft types, traffic demand, special requests, position and time when entering the XMAN horizon) shall have a minimum level of comparability in all trial sessions within one exercise.

In detail,
- No emergency, ambulance, government, flight calibration or training flights with an effect on trial's results should be happening in the trial sessions,
- The demand of departing traffic (departure traffic throughput) shall be comparable,
- The demand of arriving traffic (arrival throughput) shall be comparable,
- Constellation of arriving traffic (when entering the XMAN horizon) shall be comparable.

Flight plan and track data are required to do this check.

Note that this methodology only covers most obvious influencing factors, which can be easily determined and checked. Nevertheless this methodology cannot guarantee full comparability of baseline and trial datasets as there are still factors with the potential to distort assessment results which cannot be checked. One example for this is differences in controller competence or daily human performance.

Note also that, in case of more diverse datasets, this methodology introduces the risk of withdrawing too much data with the consequence of a very small number of remaining datasets. In order to achieve a certain significance of the results, at least 5-10 trial datasets as well as 5-10 comparable reference datasets shall be the minimum for result analysis. If this cannot be achieved, then this methodology cannot be fully applied, which leads in turn to the risk of distorted and unreliable results.

E.4 KPAs, KPIs, Metrics and Questionnaires Toolbox

The following KPIs and Metrics were described for performance assessment in PJ25, based on the SESAR performance framework as well as other publications from ICAO and CANSO regarding ATM performance. In addition, the performance methodology of the previous iStream project has been taken into account.

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
Capacity	Capacity in terminal sectors	Runway Throughput	Runway Throughput	X					DSNA	X		X					AG-Team	X	
		TMA Throughput	TMA Throughput	X					DSNA		X								
		Capacity in terminal sectors	Questionnaire / qualitative feedback	X					DSNA	X	X	X	DLR	X					
	Capacity in upstream enroute sectors	Sector Throughput	Sector Throughput																
		Capacity in upstream enroute sectors	Questionnaire / qualitative feedback	X									DLR	X			DLR		X
	Complexity in terminal sectors	ATCO workload in terminal sectors	NASA-TLX																
			ISA																
			Questionnaire / qualitative feedback	X	NATS	X	X	X	DSNA	X	X	X	DLR	X					
		ATCO situational awareness in terminal sectors	SASHA																
			Questionnaire / qualitative feedback	X	NATS	X	X		DSNA	X	X		DLR	X					
		Traffic Density	Traffic Density	X					DLR		X		DLR	X					
		Flight path diversity	Flight path diversity	X					DLR	X	X		DLR	X					

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
		Number of given radar vectors	Number of given radar vectors																
		Number of given direct routings	Number of given direct routings																
		Level dispersion at IAF	Level dispersion at IAF	X					DSNA	X	X								
		ATCO workload in upstream enroute sectors	NASA-TLX																
			ISA																
			Questionnaire / qualitative feedback	X	NATS		X	X					DLR	X			DLR		X
	Complexity in upstream enroute sectors	ATCO situational awareness in upstream enroute sectors	SASHA																
			Questionnaire / qualitative feedback	X	NATS		X										DLR		X
		Traffic Density	Traffic Density																
		Flight path diversity	Flight path diversity																
		Speed diversity	Speed diversity																
		Heading diversity	Heading diversity																
	ATFCM delays of considered	Total ATFCM delay	Total ATFCM delay	X					DSNA			X	skyguide	X	X	X			

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
	arrivals	Specific ATFCM delay	Average ATFCM delay per flight (per Airline)	X									skyguide		X	X			
			Number of regulated flights per specific traffic volume	X									skyguide		X	X			
			Number of flights delayed by more than 15min per specific traffic volume	X									skyguide		X	X			
Cost efficiency	Airspace user cost efficiency	Air Transport Time Efficiency	Air Transport Time Efficiency	X									SWISS / DLR	X		X	AG-Team	X	
		Air Transport Distance Efficiency	Air Transport Distance Efficiency	X									SWISS / DLR	X		X	AG-Team	X	
		Time efficiency in TMA	Additional ASMA time	X					DSNA	X	X	X							
			Time spent in TMA																

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
			Number of holding patterns flown in TMA	X					DSNA	X	X	X							
			Average holding time	X	NATS		X												
		Time in level flight during approach	Time in level flight during approach	X													AG-Team	X	
		Distance in level flight during approach	Distance in level flight during approach	X													AG-Team	X	
		Flown distance between IAF and TOD	Flown distance between IAF and TOD	X					DSNA		X								
		Critical passenger transfers	Saved compensation costs due to passenger misconnections	X									SWISS		X				
		Total Operational Benefit	Total Operational Benefit	X									SWISS		X				
		Qualitative Cost efficiency Aspects	Questionnaire / qualitative feedback	X	NATS			X	AFR			X							

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
	ANSP Cost Efficiency	Personnel costs (FMP / Sequencing staff)	Flights per ATCO hour on duty																
	ANSP Cost Efficiency	Personnel costs (FMP / Sequencing staff)	Questionnaire / qualitative feedback	X					DSNA		X	X							
Environment	Emissions Pollution	Fuel consumption per flight	Fuel consumption per flight	X	NATS		X	X	DLR	X	X		DLR	X					
Environment	Noise Pollution	Time per level	Time per level	X									DLR	X			AG-Team	X	
Predictability and Punctuality	Arrival Punctuality	Time difference actual - planned	Time difference actual - planned	X	NATS			X	DSNA		X	X	DLR	X		X	DFS	X	
Predictability and Punctuality	Arrival Punctuality	Time Difference ETO-TTO	Time Difference ETO-TTO	X									DLR			X			
Predictability and Punctuality	Landing sequence predictability	Landing sequence differences actual - planned	Landing sequence differences actual - planned	X					DLR	X	X	X	DLR	X		X			
Predictability and Punctuality	Spacing of arrivals on final approach	Spacing of arrivals on final approach	Landing spacing gaps	X									skyguide			X			
Predictability and Punctuality	Delay predictability	Predicted Arrival Delay	Predicted Arrival Delay	X	NATS	X													

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
		Predicted Departure Delay	Predicted Departure Delay																
Flexibility	Consideration of AU Requests	Performed / received requests ratio	Performed / received requests ratio	X					DSNA			X	skyguide			X			
			Questionnaire / qualitative feedback	X					AFR			X							
Safety	Critical Incidents	Number of STCA	Number of STCA																
		Number of TCAS alerts	Number of TCAS alerts																
		Number of separation infringements	Number of separation infringements																
		Number of incident reports	Number of incident reports	X	NATS		X		DSNA	X	X	X	skyguide	X		X	DFS	X	
	Safety Risks due to human factors	ATCo Workload	Questionnaire / qualitative feedback	X	NATS	X	X	X	DSNA	X	X	X	DLR	X			DFS/DLR	X	X
		ATCo Situational Awareness	Questionnaire / qualitative feedback	X	NATS	X	X	X	DSNA	X	X	X	DLR	X			DFS/DLR	X	X
		ATC Task Complexity	Questionnaire / qualitative feedback	X	NATS	X	X	X	DSNA	X	X	X	DLR	X			DFS/DLR	X	X

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
	Safety Risks due to procedural weaknesses	(ATCO Feedback)	Questionnaire / qualitative feedback	X	NATS	X	X		DSNA	X	X	X	DLR	X			DFS/DLR	X	X
Additional	Concept evaluation	Speed advisories	Number of advisories transmitted to upstream ACCs	X					DSNA	X	X		skyguide	X					
			Percentage of advisories implemented by ACCs	X					DSNA	X	X		skyguide	X					
			Average Horizon of Speed Advisories	X					DSNA	X	X		skyguide	X					
			Average Speed Reduction	X					DSNA	X	X		skyguide	X					
			Average time lost per flight due to XMAN speed advisories	X					DSNA	X	X		skyguide	X					
			Percentage of XMAN regulated, but re-accelerated flights	X					DSNA	X	X		skyguide	X					

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
			Average distance gap created by XMAN speed advisories	X					DSNA	X	X								
	Arrival-Departure Relation		Actual Departure Delay																
		Improved Arrival Planning	Number of transmitted TTA per Traffic Volume	X					DSNA			X							
			Percentage of implemented TTA by Network Manager	X					DSNA			X							
			TTA adherence	X					DSNA			X	DLR			X	DFS	X	
			CTOT adherence	X					DSNA			X	skyguide			X			
	General Timing of Flights		Number of early arrivals	X													DFS	X	
			Time Difference Filed-Estimated																
	Other ATFCM indicators		Percentage of improved flights	X					DSNA			X	skyguide		X				

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
			Percentage of degraded flights	X					DSNA			X	skyguide		X				
			Percentage of modified ATFCM delay per regulation	X					DSNA			X							
			Average modification of ATFCM delay	X					DSNA			X							
			Average saved ATFCM delay for improved flights	X					DSNA			X							
			Average extra ATFCM delay for degraded flights	X					DSNA			X							
			Average ATFCM delay per flight that was given priority	X									SWISS		X				
			Dispersion of ATFCM delay	X					DSNA			X							
			Average notice of TTA before off-block	X					DSNA			X							

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
			Regulated Flights with zero delay	X									skyguide			X			
			Average delay per MCP flights	X					DSNA			X	skyguide			X			

Table 1 at the end of this appendix gives an overview on the set of available KPIs, metrics and qualitative assessment that have been taken into discussion in PJ25. They are listed according to their corresponding KPA. The whole set of metrics can be understood as a toolbox which can, but not has to be used by every exercise.

In addition to the metrics and indicators directly related to the demonstration objectives, also some additional indicators were defined that are considered to be of interest by the project partners. If appropriate, these additional indicators are also reported in the exercise appendices.

E.5 Metrics Selection

In PJ25, several workshops were held to select applicable metrics per demonstration exercise from the list contained in

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
Capacity	Capacity in terminal sectors	Runway Throughput	Runway Throughput	X					DSNA	X		X					AG-Team	X	
		TMA Throughput	TMA Throughput	X					DSNA		X								
		Capacity in terminal sectors	Questionnaire / qualitative feedback	X					DSNA	X	X	X	DLR	X					
	Capacity in upstream enroute sectors	Sector Throughput	Sector Throughput																
		Capacity in upstream enroute sectors	Questionnaire / qualitative feedback	X									DLR	X			DLR		X
	Complexity in terminal sectors	ATCO workload in terminal sectors	NASA-TLX																
			ISA																
			Questionnaire / qualitative feedback	X	NATS	X	X	X	DSNA	X	X	X	DLR	X					

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
		ATCO situational awareness in terminal sectors	SASHA																
			Questionnaire / qualitative feedback	X	NATS	X	X		DSNA	X	X		DLR	X					
		Traffic Density	Traffic Density	X					DLR		X		DLR	X					
		Flight path diversity	Flight path diversity	X					DLR	X	X		DLR	X					
		Number of given radar vectors	Number of given radar vectors																
		Number of given direct routings	Number of given direct routings																
		Level dispersion at IAF	Level dispersion at IAF	X					DSNA	X	X								
	Complexity in upstream enroute sectors	ATCO workload in upstream enroute sectors	NASA-TLX																
			ISA																
			Questionnaire / qualitative feedback	X	NATS		X	X					DLR	X			DLR		X
		ATCO situational awareness in upstream enroute sectors	SASHA																
			Questionnaire / qualitative feedback	X	NATS		X										DLR		X
		Traffic Density	Traffic Density																

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
		Flight path diversity	Flight path diversity																
		Speed diversity	Speed diversity																
		Heading diversity	Heading diversity																
	ATFCM delays of considered arrivals	Total ATFCM delay	Total ATFCM delay	X					DSNA			X	skyguide	X	X	X			
		Specific ATFCM delay	Average ATFCM delay per flight (per Airline)	X									skyguide		X	X			
			Number of regulated flights per specific traffic volume	X									skyguide		X	X			
			Number of flights delayed by more than 15min per specific traffic volume	X									skyguide		X	X			
Cost efficiency	Airspace user cost efficiency	Air Transport Time Efficiency	Air Transport Time Efficiency	X									SWISS / DLR	X		X	AG-Team	X	
		Air Transport Distance Efficiency	Air Transport Distance Efficiency	X									SWISS / DLR	X		X	AG-Team	X	

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
		Time efficiency in TMA	Additional ASMA time	X					DSNA	X	X	X							
			Time spent in TMA																
			Number of holding patterns flown in TMA	X					DSNA	X	X	X							
			Average holding time	X	NATS		X												
		Time in level flight during approach	Time in level flight during approach	X													AG-Team	X	
		Distance in level flight during approach	Distance in level flight during approach	X													AG-Team	X	
		Flown distance between IAF and TOD	Flown distance between IAF and TOD	X					DSNA		X								
		Critical passenger transfers	Saved compensation costs due to passenger misconnections	X									SWISS		X				

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KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
		Total Operational Benefit	Total Operational Benefit	X									SWISS		X				
		Qualitative Cost efficiency Aspects	Questionnaire / qualitative feedback	X	NATS			X	AFR			X							
	ANSP Cost Efficiency	Personnel costs (FMP / Sequencing staff)	Flights per ATCO hour on duty																
			Questionnaire / qualitative feedback	X					DSNA		X	X							
Environment	Emissions Pollution	Fuel consumption per flight	Fuel consumption per flight	X	NATS		X	X	DLR	X	X		DLR	X					
	Noise Pollution	Time per level	Time per level	X									DLR	X			AG-Team	X	
Predictability and Punctuality	Arrival Punctuality	Time difference actual - planned	Time difference actual - planned	X	NATS			X	DSNA		X	X	DLR	X		X	DFS	X	
		Time Difference ETO-TTO	Time Difference ETO-TTO	X									DLR			X			
	Landing sequence predictability	Landing sequence differences actual - planned	Landing sequence differences actual - planned	X					DLR	X	X	X	DLR	X		X			

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
	Spacing of arrivals on final approach	Spacing of arrivals on final approach	Landing spacing gaps	X									skyguide			X			
	Delay predictability	Predicted Arrival Delay	Predicted Arrival Delay	X	NATS	X													
		Predicted Departure Delay	Predicted Departure Delay																
Flexibility	Consideration of AU Requests	Performed / received requests ratio	Performed / received requests ratio	X					DSNA			X	skyguide			X			
			Questionnaire / qualitative feedback	X					AFR			X							
Safety	Critical Incidents	Number of STCA	Number of STCA																
		Number of TCAS alerts	Number of TCAS alerts																
		Number of separation infringements	Number of separation infringements																
		Number of incident reports	Number of incident reports	X	NATS		X		DSNA	X	X	X	skyguide	X		X	DFS	X	
	Safety Risks due to human factors	ATCo Workload	Questionnaire / qualitative feedback	X	NATS	X	X	X	DSNA	X	X	X	DLR	X			DFS/DLR	X	X

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
		ATCo Situational Awareness	Questionnaire / qualitative feedback	X	NATS	X	X	X	DSNA	X	X	X	DLR	X			DFS/DLR	X	X
		ATC Task Complexity	Questionnaire / qualitative feedback	X	NATS	X	X	X	DSNA	X	X	X	DLR	X			DFS/DLR	X	X
	Safety Risks due to procedural weaknesses	(ATCO Feedback)	Questionnaire / qualitative feedback	X	NATS	X	X		DSNA	X	X	X	DLR	X			DFS/DLR	X	X
Additional	Concept evaluation	Speed advisories	Number of advisories transmitted to upstream ACCs	X					DSNA	X	X		skyguide	X					
			Percentage of advisories implemented by ACCs	X					DSNA	X	X		skyguide	X					
			Average Horizon of Speed Advisories	X					DSNA	X	X		skyguide	X					
			Average Speed Reduction	X					DSNA	X	X		skyguide	X					
			Average time lost per flight due to XMAN speed advisories	X					DSNA	X	X		skyguide	X					

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
			Percentage of XMAN regulated, but re-accelerated flights	X					DSNA	X	X		skyguide	X					
			Average distance gap created by XMAN speed advisories	X					DSNA	X	X								
		Arrival-Departure Relation	Actual Departure Delay																
		Improved Arrival Planning	Number of transmitted TTA per Traffic Volume	X					DSNA			X							
			Percentage of implemented TTA by Network Manager	X					DSNA			X							
			TTA adherence	X					DSNA			X	DLR			X	DFS	X	
			CTOT adherence	X					DSNA			X	skyguide			X			
		General Timing of Flights	Number of early arrivals	X													DFS	X	

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
			Time Difference Filed-Estimated																
		Other ATFCM indicators	Percentage of improved flights	X					DSNA			X	skyguide		X				
			Percentage of degraded flights	X					DSNA			X	skyguide		X				
			Percentage of modified ATFCM delay per regulation	X					DSNA			X							
			Average modification of ATFCM delay	X					DSNA			X							
			Average saved ATFCM delay for improved flights	X					DSNA			X							
			Average extra ATFCM delay for degraded flights	X					DSNA			X							
			Average ATFCM delay per flight that was given priority	X									SWISS		X				

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
			Dispersion of ATFCM delay	X					DSNA			X							
			Average notice of TTA before off-block	X					DSNA			X							
			Regulated Flights with zero delay	X									skyguide			X			
			Average delay per MCP flights	X					DSNA			X	skyguide			X			

Table 1.

In detail, these workshops took place:

- 19th September 2018 in Southhampton, UK, at NATS premises for WP6 exercises,

- 11th June 2018 in Athis-Mons, France, at DSNA premises for WP7 exercises,

- 24th July 2018 in Zürich, Switzerland, at ZRH Airport for WP8 exercises,

- 6th/7th February 2019 in Langen, Germany, at DFS premises for WP9 exercises.

Additionally, several coordination webexes were held whenever needed.

As an outcome, the applicable metrics and indicators to be measured in every single exercise were selected, based on defined demonstration objectives per exercise according to the demonstration plan. This selection is also indicated in

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
Capacity	Capacity in terminal sectors	Runway Throughput	Runway Throughput	X					DSNA	X		X					AG-Team	X	
		TMA Throughput	TMA Throughput	X					DSNA		X								
		Capacity in terminal sectors	Questionnaire / qualitative feedback	X					DSNA	X	X	X	DLR	X					
	Capacity in upstream enroute sectors	Sector Throughput	Sector Throughput																
		Capacity in upstream enroute sectors	Questionnaire / qualitative feedback	X									DLR	X			DLR		X
	Complexity in terminal sectors	ATCO workload in terminal sectors	NASA-TLX																
			ISA																
			Questionnaire / qualitative feedback	X	NATS	X	X	X	DSNA	X	X	X	DLR	X					
		ATCO situational awareness in terminal sectors	SASHA																
			Questionnaire / qualitative feedback	X	NATS	X	X		DSNA	X	X		DLR	X					
		Traffic Density	Traffic Density	X					DLR		X		DLR	X					
		Flight path diversity	Flight path diversity	X					DLR	X	X		DLR	X					

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
		Number of given radar vectors	Number of given radar vectors																
		Number of given direct routings	Number of given direct routings																
		Level dispersion at IAF	Level dispersion at IAF	X					DSNA	X	X								
		ATCO workload in upstream enroute sectors	NASA-TLX																
			ISA																
	Complexity in upstream enroute sectors		Questionnaire / qualitative feedback	X	NATS		X	X					DLR	X			DLR		X
		ATCO situational awareness in upstream enroute sectors	SASHA																
			Questionnaire / qualitative feedback	X	NATS		X										DLR		X
		Traffic Density	Traffic Density																
		Flight path diversity	Flight path diversity																
		Speed diversity	Speed diversity																
		Heading diversity	Heading diversity																
	ATFCM delays of considered	Total ATFCM delay	Total ATFCM delay	X					DSNA			X	skyguide	X	X	X		

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
	arrivals	Specific ATFCM delay	Average ATFCM delay per flight (per Airline)	X									skyguide		X	X			
			Number of regulated flights per specific traffic volume	X									skyguide		X	X			
			Number of flights delayed by more than 15min per specific traffic volume	X									skyguide		X	X			
Cost efficiency	Airspace user cost efficiency	Air Transport Time Efficiency	Air Transport Time Efficiency	X									SWISS / DLR	X		X	AG-Team	X	
		Air Transport Distance Efficiency	Air Transport Distance Efficiency	X									SWISS / DLR	X		X	AG-Team	X	
		Time efficiency in TMA	Additional ASMA time	X					DSNA	X	X	X							
			Time spent in TMA																

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
			Number of holding patterns flown in TMA	X					DSNA	X	X	X							
			Average holding time	X	NATS		X												
		Time in level flight during approach	Time in level flight during approach	X													AG-Team	X	
		Distance in level flight during approach	Distance in level flight during approach	X													AG-Team	X	
		Flown distance between IAF and TOD	Flown distance between IAF and TOD	X					DSNA		X								
		Critical passenger transfers	Saved compensation costs due to passenger misconnections	X									SWISS		X				
		Total Operational Benefit	Total Operational Benefit	X									SWISS		X				
		Qualitative Cost efficiency Aspects	Questionnaire / qualitative feedback	X	NATS			X	AFR			X							

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KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
	ANSP Cost Efficiency	Personnel costs (FMP / Sequencing staff)	Flights per ATCO hour on duty																
			Questionnaire / qualitative feedback	X					DSNA		X	X							
Environment	Emissions Pollution	Fuel consumption per flight	Fuel consumption per flight	X	NATS		X	X	DLR	X	X		DLR	X					
	Noise Pollution	Time per level	Time per level	X									DLR	X			AG-Team	X	
Predictability and Punctuality	Arrival Punctuality	Time difference actual - planned	Time difference actual - planned	X	NATS			X	DSNA		X	X	DLR	X		X	DFS	X	
		Time Difference ETO-TTO	Time Difference ETO-TTO	X									DLR			X			
	Landing sequence predictability	Landing sequence differences actual - planned	Landing sequence differences actual - planned	X					DLR	X	X	X	DLR	X		X			
	Spacing of arrivals on final approach	Spacing of arrivals on final approach	Landing spacing gaps	X									skyguide			X			
	Delay predictability	Predicted Arrival Delay	Predicted Arrival Delay	X	NATS	X													

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
		Predicted Departure Delay	Predicted Departure Delay																
Flexibility	Consideration of AU Requests	Performed / received requests ratio	Performed / received requests ratio	X					DSNA			X	skyguide			X			
			Questionnaire / qualitative feedback	X					AFR			X							
Safety	Critical Incidents	Number of STCA	Number of STCA																
		Number of TCAS alerts	Number of TCAS alerts																
		Number of separation infringements	Number of separation infringements																
		Number of incident reports	Number of incident reports	X	NATS		X		DSNA	X	X	X	skyguide	X		X	DFS	X	
	Safety Risks due to human factors	ATCo Workload	Questionnaire / qualitative feedback	X	NATS	X	X	X	DSNA	X	X	X	DLR	X			DFS/DLR	X	X
		ATCo Situational Awareness	Questionnaire / qualitative feedback	X	NATS	X	X	X	DSNA	X	X	X	DLR	X			DFS/DLR	X	X
		ATC Task Complexity	Questionnaire / qualitative feedback	X	NATS	X	X	X	DSNA	X	X	X	DLR	X			DFS/DLR	X	X

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
	Safety Risks due to procedural weaknesses	(ATCO Feedback)	Questionnaire / qualitative feedback	X	NATS	X	X		DSNA	X	X	X	DLR	X			DFS/DLR	X	X
Additional	Concept evaluation	Speed advisories	Number of advisories transmitted to upstream ACCs	X					DSNA	X	X		skyguide	X					
			Percentage of advisories implemented by ACCs	X					DSNA	X	X		skyguide	X					
			Average Horizon of Speed Advisories	X					DSNA	X	X		skyguide	X					
			Average Speed Reduction	X					DSNA	X	X		skyguide	X					
			Average time lost per flight due to XMAN speed advisories	X					DSNA	X	X		skyguide	X					
			Percentage of XMAN regulated, but re-accelerated flights	X					DSNA	X	X		skyguide	X					

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KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
			Average distance gap created by XMAN speed advisories	X					DSNA	X	X								
	Arrival-Departure Relation		Actual Departure Delay																
	Improved Arrival Planning		Number of transmitted TTA per Traffic Volume	X					DSNA			X							
			Percentage of implemented TTA by Network Manager	X					DSNA			X							
			TTA adherence	X					DSNA			X	DLR		X		DFS	X	
			CTOT adherence	X					DSNA			X	skyguide		X				
	General Timing of Flights		Number of early arrivals	X													DFS	X	
			Time Difference Filed-Estimated																
	Other ATFCM indicators		Percentage of improved flights	X					DSNA			X	skyguide		X				

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KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
			Percentage of degraded flights	X					DSNA			X	skyguide		X				
			Percentage of modified ATFCM delay per regulation	X					DSNA			X							
			Average modification of ATFCM delay	X					DSNA			X							
			Average saved ATFCM delay for improved flights	X					DSNA			X							
			Average extra ATFCM delay for degraded flights	X					DSNA			X							
			Average ATFCM delay per flight that was given priority	X									SWISS		X				
			Dispersion of ATFCM delay	X					DSNA			X							
			Average notice of TTA before off-block	X					DSNA			X							

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
			Regulated Flights with zero delay	X									skyguide			X			
			Average delay per MCP flights	X					DSNA			X	skyguide			X			

Table 1 with an "X" on green background per metric and exercise.

E.6 Used Qualitative Assessment Methods

Whenever suitable, a quantitative assessment including a baseline-solution comparison of selected performance indicators was supplemented also with a qualitative assessment. In some other cases, a qualitative assessment was the only option due to data availability or for other reasons.

A qualitative assessment can be done by (beside others):

- using standard questionnaires, e.g. Eurocontrol SHAPE questionnaires to assess workload, situation awareness and mental capacity of the controller,

- using tailor-made questionnaires (TMQ),

- using interview techniques in the frame of de-briefing sessions or workshops related to the exercise.

It has been decided in the mentioned workshops that for safety reasons all qualitative assessments in PJ25 are performed as post-run assessment, which excludes methods like instantaneous self-assessment (ISA), which would have to be done in real-time by regularly interrogating the controller or operator taking part in the trial run.

When choosing qualitative assessment methods it has to be ensured that:

- the right persons are asked / interviewed: only those people with enough insights into the concerned operational environment shall be asked. Further, only those people without bias should be asked for their feedback (e.g. persons who have developed a new procedure shall not be asked for their opinion about its benefit as the answer may not be fully dispassionate),

- the right question should be asked: the question must be fully understandable, fully aiming at the aspect to investigate and shall not leave room for interpretation or misunderstandings,

- enough persons should be asked: in order to achieve a result which is representative and which does not just reflect the opinion of very few individuals, a minimum number of experts shall be involved in the qualitative assessment (at least 5).

As far as possible, the idea of a baseline-solution comparison shall also be kept in mind for qualitative assessment. This can be achieved by asking explicitly for the effect of the improvement, compared to what is considered "normal operations".

E.7 Workshare and Responsibilities for Performance Assessment in PJ25 xStream

It was also comprehensively discussed between partners which analysis tools are available and suitable to make the performance assessment. Due to the composition of the project consortium, involving ANSPs, airlines, airport operating agencies and research institutions, a wide variety of analysis tools and access to different data sources is available in the project. In order to save time and resources it was agreed that whenever possible the most appropriate tool is used for the analysis, which is then done by the respective owner of the tool. Consequently, a certain indicator or metric was intended to calculated by the partner who can do that with the least effort. For example, as ANSPs are continuously monitoring their own ATM performance and often have tools which are ready to be used to measure performance indicators like delay figures, it does not make sense that

this measurement is done by another partner. In these cases, AT-One / DLR as WP5 leader only defined which measurement is done by whom with which tools and supervised the activity, while the performance calculation itself was done by the appropriate partner with the available tools and data.

The responsibilities and the workshare between partners for making the performance calculations has also been discussed and negotiated in the workshops listed in section E.5. The outcome is also visible   in

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
Capacity	Capacity in terminal sectors	Runway Throughput	Runway Throughput	X					DSNA	X		X					AG-Team	X	
		TMA Throughput	TMA Throughput	X					DSNA		X								
		Capacity in terminal sectors	Questionnaire / qualitative feedback	X					DSNA	X	X	X	DLR	X					
	Capacity in upstream enroute sectors	Sector Throughput	Sector Throughput																
		Capacity in upstream enroute sectors	Questionnaire / qualitative feedback	X									DLR	X			DLR		X
	Complexity in terminal sectors	ATCO workload in terminal sectors	NASA-TLX																
			ISA																
			Questionnaire / qualitative feedback	X	NATS	X	X	X	DSNA	X	X	X	DLR	X					
		ATCO situational awareness in terminal sectors	SASHA																
			Questionnaire / qualitative feedback	X	NATS	X	X		DSNA	X	X		DLR	X					
		Traffic Density	Traffic Density	X					DLR		X		DLR	X					
		Flight path diversity	Flight path diversity	X					DLR	X	X		DLR	X					

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
		Number of given radar vectors	Number of given radar vectors																
		Number of given direct routings	Number of given direct routings																
		Level dispersion at IAF	Level dispersion at IAF	X					DSNA	X	X								
	Complexity in upstream enroute sectors	ATCO workload in upstream enroute sectors	NASA-TLX																
			ISA																
			Questionnaire / qualitative feedback	X	NATS		X	X					DLR	X			DLR		X
		ATCO situational awareness in upstream enroute sectors	SASHA																
			Questionnaire / qualitative feedback	X	NATS		X										DLR		X
		Traffic Density	Traffic Density																
		Flight path diversity	Flight path diversity																
		Speed diversity	Speed diversity																
		Heading diversity	Heading diversity																
	ATFCM delays of considered	Total ATFCM delay	Total ATFCM delay	X					DSNA			X	skyguide	X	X	X			

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
	arrivals	Specific ATFCM delay	Average ATFCM delay per flight (per Airline)	X									skyguide		X	X			
			Number of regulated flights per specific traffic volume	X									skyguide		X	X			
			Number of flights delayed by more than 15min per specific traffic volume	X									skyguide		X	X			
Cost efficiency	Airspace user cost efficiency	Air Transport Time Efficiency	Air Transport Time Efficiency	X									SWISS / DLR	X		X	AG-Team	X	
		Air Transport Distance Efficiency	Air Transport Distance Efficiency	X									SWISS / DLR	X		X	AG-Team	X	
		Time efficiency in TMA	Additional ASMA time	X					DSNA	X	X	X							
			Time spent in TMA																

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
			Number of holding patterns flown in TMA	X					DSNA	X	X	X							
			Average holding time	X	NATS		X												
		Time in level flight during approach	Time in level flight during approach	X													AG-Team	X	
		Distance in level flight during approach	Distance in level flight during approach	X													AG-Team	X	
		Flown distance between IAF and TOD	Flown distance between IAF and TOD	X					DSNA		X								
		Critical passenger transfers	Saved compensation costs due to passenger misconnections	X									SWISS		X				
		Total Operational Benefit	Total Operational Benefit	X									SWISS		X				
		Qualitative Cost efficiency Aspects	Questionnaire / qualitative feedback	X	NATS			X	AFR			X							

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KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
	ANSP Cost Efficiency	Personnel costs (FMP / Sequencing staff)	Flights per ATCO hour on duty																
			Questionnaire / qualitative feedback	X					DSNA		X	X							
Environment	Emissions Pollution	Fuel consumption per flight	Fuel consumption per flight	X	NATS		X	X	DLR	X	X		DLR	X					
	Noise Pollution	Time per level	Time per level	X									DLR	X			AG-Team	X	
Predictability and Punctuality	Arrival Punctuality	Time difference actual - planned	Time difference actual - planned	X	NATS			X	DSNA		X	X	DLR	X		X	DFS	X	
		Time Difference ETO-TTO	Time Difference ETO-TTO	X									DLR			X			
	Landing sequence predictability	Landing sequence differences actual - planned	Landing sequence differences actual - planned	X					DLR	X	X	X	DLR	X		X			
	Spacing of arrivals on final approach	Spacing of arrivals on final approach	Landing spacing gaps	X									skyguide			X			
	Delay predictability	Predicted Arrival Delay	Predicted Arrival Delay	X	NATS	X													

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
		Predicted Departure Delay	Predicted Departure Delay																
Flexibility	Consideration of AU Requests	Performed / received requests ratio	Performed / received requests ratio	X					DSNA			X	skyguide			X			
			Questionnaire / qualitative feedback	X					AFR			X							
Safety	Critical Incidents	Number of STCA	Number of STCA																
		Number of TCAS alerts	Number of TCAS alerts																
		Number of separation infringements	Number of separation infringements																
		Number of incident reports	Number of incident reports	X	NATS		X		DSNA	X	X	X	skyguide	X		X	DFS	X	
	Safety Risks due to human factors	ATCo Workload	Questionnaire / qualitative feedback	X	NATS	X	X	X	DSNA	X	X	X	DLR	X			DFS/DLR	X	X
		ATCo Situational Awareness	Questionnaire / qualitative feedback	X	NATS	X	X	X	DSNA	X	X	X	DLR	X			DFS/DLR	X	X
		ATC Task Complexity	Questionnaire / qualitative feedback	X	NATS	X	X	X	DSNA	X	X	X	DLR	X			DFS/DLR	X	X

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
	Safety Risks due to procedural weaknesses	(ATCO Feedback)	Questionnaire / qualitative feedback	X	NATS	X	X		DSNA	X	X	X	DLR	X			DFS/DLR	X	X
Additional	Concept evaluation	Speed advisories	Number of advisories transmitted to upstream ACCs	X					DSNA	X	X		skyguide	X					
			Percentage of advisories implemented by ACCs	X					DSNA	X	X		skyguide	X					
			Average Horizon of Speed Advisories	X					DSNA	X	X		skyguide	X					
			Average Speed Reduction	X					DSNA	X	X		skyguide	X					
			Average time lost per flight due to XMAN speed advisories	X					DSNA	X	X		skyguide	X					
			Percentage of XMAN regulated, but re-accelerated flights	X					DSNA	X	X		skyguide	X					

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
			Average distance gap created by XMAN speed advisories	X					DSNA	X	X								
		Arrival-Departure Relation	Actual Departure Delay																
		Improved Arrival Planning	Number of transmitted TTA per Traffic Volume	X					DSNA			X							
			Percentage of implemented TTA by Network Manager	X					DSNA			X							
			TTA adherence	X					DSNA			X	DLR			X	DFS	X	
			CTOT adherence	X					DSNA			X	skyguide			X			
		General Timing of Flights	Number of early arrivals	X													DFS	X	
			Time Difference Filed-Estimated																
		Other ATFCM indicators	Percentage of improved flights	X					DSNA			X	skyguide		X				

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
			Percentage of degraded flights	X					DSNA			X	skyguide		X				
			Percentage of modified ATFCM delay per regulation	X					DSNA			X							
			Average modification of ATFCM delay	X					DSNA			X							
			Average saved ATFCM delay for improved flights	X					DSNA			X							
			Average extra ATFCM delay for degraded flights	X					DSNA			X							
			Average ATFCM delay per flight that was given priority	X									SWISS		X				
			Dispersion of ATFCM delay	X					DSNA			X							
			Average notice of TTA before off-block	X					DSNA			X							

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
			Regulated Flights with zero delay	X									skyguide			X			
			Average delay per MCP flights	X					DSNA			X	skyguide			X			

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Table 1.

Whenever a partner was foreseen to analyse data which he does not own and which he has to receive from another partner (mainly DLR, which received data from DSNA and skyguide for result analysis), a non-disclosure agreement (NDA) had to be negotiated. Without this agreement, a data transfer was not authorized; concerned metrics and indicators had to be de-selected again. Whenever the fulfilment of any demonstration objective was endangered, mitigation actions were taken (e.g. switch to qualitative assessment).

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
Capacity	Capacity in terminal sectors	Runway Throughput	Runway Throughput	X					DSNA	X		X					AG-Team	X	
		TMA Throughput	TMA Throughput	X					DSNA		X								
		Capacity in terminal sectors	Questionnaire / qualitative feedback	X					DSNA	X	X	X	DLR	X					
	Capacity in upstream enroute sectors	Sector Throughput	Sector Throughput																
		Capacity in upstream enroute sectors	Questionnaire / qualitative feedback	X									DLR	X			DLR		X
	Complexity in terminal sectors	ATCO workload in terminal sectors	NASA-TLX																
			ISA																
			Questionnaire / qualitative feedback	X	NATS	X	X	X	DSNA	X	X	X	DLR	X					
		ATCO situational awareness in terminal sectors	SASHA																
			Questionnaire / qualitative feedback	X	NATS	X	X		DSNA	X	X		DLR	X					
		Traffic Density	Traffic Density	X					DLR		X		DLR	X					
		Flight path diversity	Flight path diversity	X					DLR	X	X		DLR	X					
		Number of given radar vectors	Number of given radar vectors																

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
		Number of given direct routings	Number of given direct routings																
		Level dispersion at IAF	Level dispersion at IAF	X					DSNA	X	X								
		ATCO workload in upstream enroute sectors	NASA-TLX																
			ISA																
			Questionnaire / qualitative feedback	X	NATS		X	X					DLR	X			DLR		X
	Complexity in upstream enroute sectors	ATCO situational awareness in upstream enroute sectors	SASHA																
			Questionnaire / qualitative feedback	X	NATS		X										DLR		X
		Traffic Density	Traffic Density																
		Flight path diversity	Flight path diversity																
		Speed diversity	Speed diversity																
		Heading diversity	Heading diversity																
	ATFCM delays of considered arrivals	Total ATFCM delay	Total ATFCM delay	X					DSNA			X	skyguide	X	X	X			
		Specific ATFCM delay	Average ATFCM delay per flight (per Airline)	X									skyguide		X	X			

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
			Number of regulated flights per specific traffic volume	X									skyguide		X	X			
			Number of flights delayed by more than 15min per specific traffic volume	X									skyguide		X	X			
Cost efficiency	Airspace user cost efficiency	Air Transport Time Efficiency	Air Transport Time Efficiency	X									SWISS / DLR	X		X	AG-Team	X	
		Air Transport Distance Efficiency	Air Transport Distance Efficiency	X									SWISS / DLR	X		X	AG-Team	X	
		Time efficiency in TMA	Additional ASMA time	X					DSNA	X	X	X							
			Time spent in TMA																
			Number of holding patterns flown in TMA	X					DSNA	X	X	X							

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
			Average holding time	X	NATS		X												
		Time in level flight during approach	Time in level flight during approach	X													AG-Team	X	
		Distance in level flight during approach	Distance in level flight during approach	X													AG-Team	X	
		Flown distance between IAF and TOD	Flown distance between IAF and TOD	X					DSNA		X								
		Critical passenger transfers	Saved compensation costs due to passenger misconnections	X									SWISS		X				
		Total Operational Benefit	Total Operational Benefit	X									SWISS		X				
		Qualitative Cost efficiency Aspects	Questionnaire / qualitative feedback	X	NATS			X	AFR		X								
	ANSP Cost Efficiency	Personnel costs (FMP / Sequencing)	Flights per ATCO hour on duty																

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
		staff)	Questionnaire / qualitative feedback	X					DSNA		X	X							
Environment	Emissions Pollution	Fuel consumption per flight	Fuel consumption per flight	X	NATS		X	X	DLR	X	X		DLR	X					
	Noise Pollution	Time per level	Time per level	X									DLR	X			AG-Team	X	
Predictability and Punctuality	Arrival Punctuality	Time difference actual - planned	Time difference actual - planned	X	NATS			X	DSNA		X	X	DLR	X		X	DFS	X	
		Time Difference ETO-TTO	Time Difference ETO-TTO	X									DLR			X			
	Landing sequence predictability	Landing sequence differences actual - planned	Landing sequence differences actual - planned	X					DLR	X	X	X	DLR	X		X			
	Spacing of arrivals on final approach	Spacing of arrivals on final approach	Landing spacing gaps	X									skyguide			X			
	Delay predictability	Predicted Arrival Delay	Predicted Arrival Delay	X	NATS	X													
		Predicted Departure Delay	Predicted Departure Delay																

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
Flexibility	Consideration of AU Requests	Performed / received requests ratio	Performed / received requests ratio	X					DSNA			X	skyguide			X			
			Questionnaire / qualitative feedback	X					AFR			X							
Safety	Critical Incidents	Number of STCA	Number of STCA																
		Number of TCAS alerts	Number of TCAS alerts																
		Number of separation infringements	Number of separation infringements																
		Number of incident reports	Number of incident reports	X	NATS		X		DSNA	X	X	X	skyguide	X		X	DFS	X	
	Safety Risks due to human factors	ATCo Workload	Questionnaire / qualitative feedback	X	NATS	X	X	X	DSNA	X	X	X	DLR	X			DFS/DLR	X	X
		ATCo Situational Awareness	Questionnaire / qualitative feedback	X	NATS	X	X	X	DSNA	X	X	X	DLR	X			DFS/DLR	X	X
		ATC Task Complexity	Questionnaire / qualitative feedback	X	NATS	X	X	X	DSNA	X	X	X	DLR	X			DFS/DLR	X	X
	Safety Risks due to procedural weaknesses	(ATCO Feedback)	Questionnaire / qualitative feedback	X	NATS	X	X		DSNA	X	X	X	DLR	X			DFS/DLR	X	X

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
Additional	Concept evaluation	Speed advisories	Number of advisories transmitted to upstream ACCs	X					DSNA	X	X		skyguide	X					
			Percentage of advisories implemented by ACCs	X					DSNA	X	X		skyguide	X					
			Average Horizon of Speed Advisories	X					DSNA	X	X		skyguide	X					
			Average Speed Reduction	X					DSNA	X	X		skyguide	X					
			Average time lost per flight due to XMAN speed advisories	X					DSNA	X	X		skyguide	X					
			Percentage of XMAN regulated, but re-accelerated flights	X					DSNA	X	X		skyguide	X					
			Average distance gap created by XMAN speed advisories	X					DSNA	X	X								

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
		Arrival-Departure Relation	Actual Departure Delay																
		Improved Arrival Planning	Number of transmitted TTA per Traffic Volume	X					DSNA			X							
			Percentage of implemented TTA by Network Manager	X					DSNA			X							
			TTA adherence	X					DSNA			X	DLR			X	DFS	X	
			CTOT adherence	X					DSNA			X	skyguide			X			
		General Timing of Flights	Number of early arrivals	X													DFS	X	
			Time Difference Filed-Estimated																
		Other ATFCM indicators	Percentage of improved flights	X					DSNA			X	skyguide		X				
			Percentage of degraded flights	X					DSNA			X	skyguide		X				

KPA	Sub-Category	(K)PI / Aspect	Available Metrics	Overall Use	Evaluated by	EXE-VLD-06-001	EXE-VLD-06-002	EXE-VLD-06-003	Evaluated by	EXE-VLD-07-001	EXE-VLD-07-002	EXE-VLD-07-003	Evaluated by	EXE-VLD-08-001	EXE-VLD-08-002	EXE-VLD-08-003	Evaluated by	EXE-VLD-09-002	EXE-VLD-09-003
			Percentage of modified ATFCM delay per regulation	X					DSNA			X							
			Average modification of ATFCM delay	X					DSNA			X							
			Average saved ATFCM delay for improved flights	X					DSNA			X							
			Average extra ATFCM delay for degraded flights	X					DSNA			X							
			Average ATFCM delay per flight that was given priority	X									SWISS		X				
			Dispersion of ATFCM delay	X					DSNA			X							
			Average notice of TTA before off-block	X					DSNA			X							
			Regulated Flights with zero delay	X									skyguide			X			
			Average delay per MCP flights	X					DSNA			X	skyguide			X			

Table 1: List of Indicators and Metrics defined (white columns) and selected (green X) for the assessment in PJ25; agreed responsibility for calculation is also indicated