Annex to SESAR Deployment Programme

(Edition 2017)

on

Performance Assessment and Cost Benefit Analysis Methodology

FPA MOVE/E2/2014-717/SESAR FPA
SGA MOVE/E3/SUB/2016-402/SI2.745134

Deliverable D1.1

PROPOSAL FOR UPDATE

31st May 2017

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1. Introduction

The **translation of PCP into DP and then into projects** induces a significant refinement of the costs compared to the assumptions used for the PCP CBA defined in 2013 by the SESAR Joint Undertaking (SJU). At the same time, **additional inputs, from the implementing stakeholders and new analysis from the SDM or the SJU**, in close cooperation with Network Manager, allow refining the benefits side.

Therefore, it is SDM's intention to **analyse refined costs and expected benefits based on performance related data** to be collected through CEF Calls for Proposals, and relevant inputs from the Network Manager (e.g. National Operational Plan (NOP) and European Route Network Improvement Plan (ERNIP). These analysis and subsequent monitoring once projects are awarded and running are to be done **with the methodology defined in this document**.

This methodology is elaborated for the **purpose of compliance with Commission Implementing Regulation (EU) No 409/2013** and more specifically to **assess the effectiveness of coordination and synchronisation of the Deployment Programme** (DP).

While the PCP CBA[1] and the underlying methodology constitute the general reference for performance expectations at AF level, it is clear that, at the time the projects are submitted, their **contribution to performance shall be identified and possibly quantified at a much greater level of detail**. Later on, at the time the projects are awarded, the CBAs of the projects shall be calculated and finally, the global CBA of the Deployment Programme shall be built up summing the different parts being actually deployed or that will be deployed.

The methodology covers the process of **identifying and quantifying the benefits**. It does also explain how projects could be combined into **threads to facilitate the calculation of CBA** and how the consolidation both on benefits and on costs shall occur to build a global CBA for the Deployment Programme.

The methodology also defines **rules of monitoring benefits and costs and considerations in terms of estimating accuracy**.

Through 2015 and 2016, this methodology has been tested and improved. It is expected to be stable enough to be pursued over the next periods, notwithstanding the possibility to take on board further improvements if necessary.

The requested information and data allowing to elaborate CBAs are uploaded by the respective stakeholders manages in the STAR tool[2].

2. Benefits

2.1. Identifying benefits

2.1.1. Key Performance Areas (KPAs), Performance Indicators and CBA metrics

The KPAs that are monitored at deployment level are those of the SES performance regulation (EU IR 390/2013) and from those reflected in the ATM Master Plan (Edition 2015).

The KPAs are Cost Efficiency, Capacity, Operational Efficiency and Environment[3].

The following pictures and corresponding grids give an overview of **ATM Functionalities** and the definition of the **Performance Indicators** used and their relation with KPAs.

[1] Cost Benefits Analysis
[2] SESAR Tool for ATM Roll-out
[3] Flight efficiency and capacity are monetized through savings of fuel and operational costs (i.e. reduction of delays, shorter flight-routes). Environmental impact is monetized through CO2 reductions. Cost efficiency is monetized through ATCO productivity and ANS cost reductions.

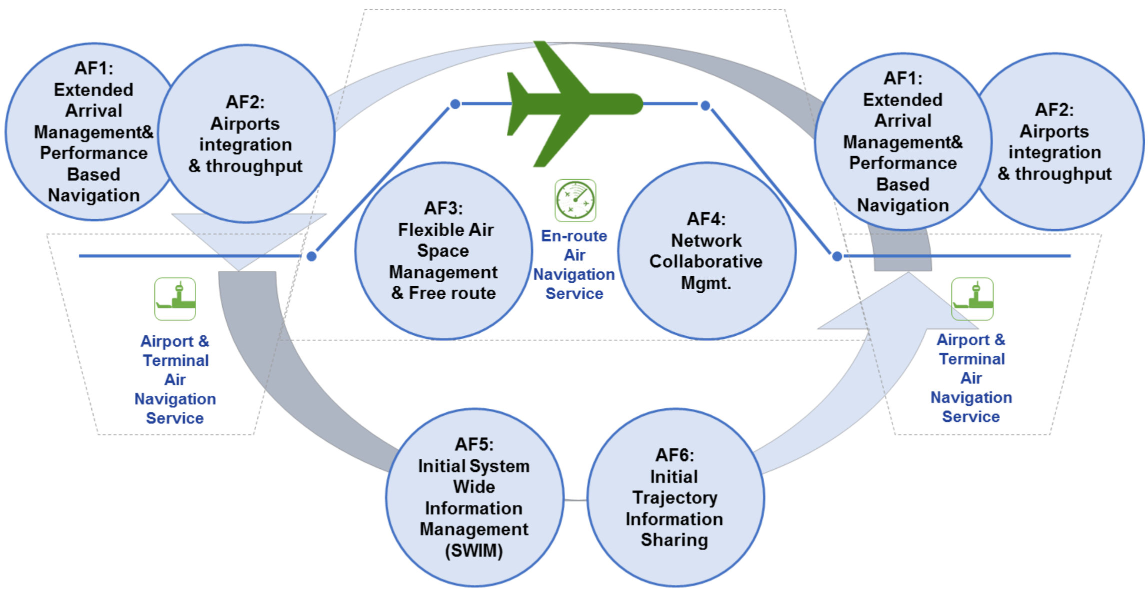

Fig. 1 – Overview of ATM Functionalities

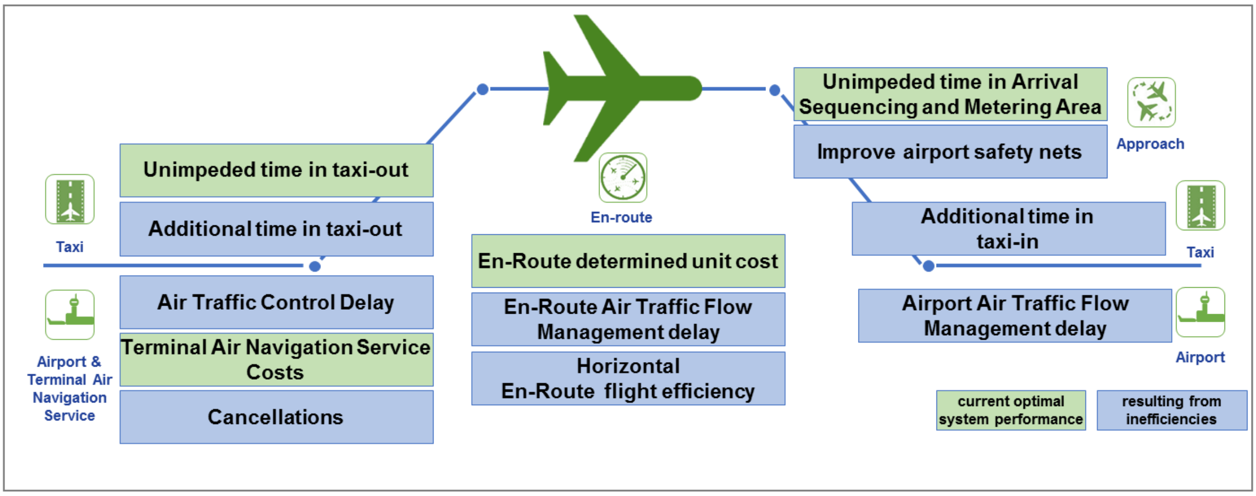

Fig. 2 – Performance Indicators

- In green, Performance Indicators refer to “strategic” inefficiencies, for example due to current airspace design, that is to say which refer to the reduction of delay that is included in airline schedules (flight plan).
- In blue, Performance Indicators resulting from inefficiencies, so called “tactical” inefficiencies that is to say inefficiencies referring to the unpredictable delays on the day of operations that exceeds the delay buffer foreseen in the flight plan.

Airport ATFM delay[1]

Definition	Comment	KPA	Formula	Unit	Delay
Arrival Airport ATFM delay per flight attributable to terminal and airport air navigation services and caused by landing restrictions at the destination airport.	None	Capacity	Arrival ATFM delay per inbound IFR flight attributable to terminal and airport air navigation services	Minutes per arrival flights	Tactical Ground

[1] Reference to IR 390/2013

ATC delay[1]

Definition	Comment	KPA	Formula	Unit	Delay
All IFR flights taking off at the departure airport and covers delays in start-up due to air traffic control constraints when the aircraft is ready to leave the departure stand	The ATC delay (or ATC pre-departure delay) is the additional time that the aircraft is held at the stand to avoid queuing at the departure runway. It is a proxy of the delay which an aircraft ready to leave its gate can be subject to, at its origin airport, due to airports constraints, demand/capacity imbalances known prior to off-blocks, take-off restrictions and/or traffic intensity at the time of operations.	Ops efficiency	Air traffic control delay per outbound IFR flight caused by take-off restrictions at the departure airport. The causes for ATC pre-departure delay means the standard IATA delay codes as defined in Section F of Digest Annual 2011 'Delays to Air Transport in Europe', with the duration of the delay. These delay causes relate to IATA delay Code 89 that aims at capturing off-block delays due to local ATC and pushback when the aircraft is ready to leave its stand. More specifically, these codes aim at reporting restrictions at airport of departure, including Air Traffic Services, start-up and pushback, airport and/or runway closed due to obstruction or weather, industrial action, staff shortage, political unrest, noise abatement, night curfew, special flights	Minutes per departure flights	Tactical Ground

Unimpeded taxi-out time[1]

Definition	Comment	KPA	Formula	Unit	Delay
The actual taxi-out time of a flight is the time elapsed between the off-block time of this flight and its take-off time. The unimpeded taxi-out time is the taxi-out time in non- congested conditions at airports. Taxi-out time includes possible push-day delay, possible remote de-icing time, and departure runway occupancy time.	The unimpeded taxi-out time which is related to the airport layout (gates, runways…). This time are considered as "strategic" because it is included in the flight time calculated by the Airlines. Engines are on.	Ops efficiency	Based on taxi-out times in low periods of traffic. A different unimpeded taxi-out time is determined for each combination: departure runway; and, departure stand (or group of stands).	Minutes per departure flights	Strategic – airborne

Additional taxi-out time[1]

Definition	Comment	KPA	Formula	Unit	Delay
The additional taxi-out time is a proxy for the average departure runway queuing time on the outbound traffic flow, during congestion periods at airports.	The additional time in taxi-out due to congestion on the airport, bad weather conditions… engines are on. those delays are considered as tactical	Ops efficiency	It is the difference between the actual taxi-out time of a flight and a statistically determined based on taxi-out times in periods of low traffic demand.	Minutes per departure flights	Tactical - airborne

[1] Reference to IR 390/2013

Unimpeded time in taxi-in[1]

Definition	Comment	KPA	Formula	Unit	Delay
Refers to the period between the time when the aircraft landed and the time it arrives at the stand.	The unimpeded taxi-in time which is related to the "structure" of the airport (gates, runways). This time are considered as "strategic" because it is included in the flight time calculated by the Airlines, engines are on.	Ops efficiency	Reference taxi-in time based on the 20th percentile of the associated stand-runway combination.	Minutes per arrival flights	Strategic - airborne

Additional time in taxi-in[2]

Definition	Comment	KPA	Formula	Unit	Delay
Refers to the period between the time when the aircraft landed and the time it arrives at the stand.	The additional time in taxi-in due to congestion on the airport, bad weather conditions… Engines are on; those delays are considered as tactical.	Ops efficiency	For each arrival, the additional time is computed as the difference between its actual taxi-in time and the unimpeded taxi-in time. In case the actual taxi-in time is equal or less than the reference taxi-in time, the additional time is set to zero	Minutes per arrival flights	Tactical - airborne

Unimpeded ASMA time[1]

Definition	Comment	KPA	Formula	Unit	Delay
The unimpeded ASMA time is the ASMA transit time in non-congested conditions at arrival airports.	The unimpeded ASMA time, which is related to the "structure" of the ASMA (~TMA). This time is considered as "strategic" because it is included in the flight time calculated by the Airlines. Engines are on.	Ops efficiency	It is determined for each group of flights with the same parameters (i.e. aircraft class, ASMA entry sector, arrival runway) and represents the transit time in non-congested conditions	Minutes per arrival flights	Strategic - airborne

Additional ASMA time[1]

Definition	Comment	KPA	Formula	Unit	Delay
The additional ASMA time is a proxy for airport inefficiencies in the approach phase, proxy for the average arrival runway queuing time on the inbound traffic flow, during congestion periods at airports	The additional time in ASMA due to congestion in ASMA… Engines are on; those delays are considered as tactical.	Ops efficiency	The indicator is the difference between the actual ASMA (Arrival Sequencing and Metering Area) transit time and the unimpeded ASMA time calculated for non-congested conditions	Minutes per arrival flights	Tactical - airborne

En-route ATFM delay[2]

Definition	Comment	KPA	Formula	Unit	Delay
Minutes of en route ATFM (Air Traffic Flow Management) delays per flight attributable to air navigation services. Note: en route ATFM delays take into account delays, which is due to	ANS-related holding at gate due to En Route Airspace = En Route ATFM delays. Engines are off, those delays are considered as tactical	Capacity	The en route ATFM delay is the delay calculated by the central unit of ATFM as defined in Commission Regulation (EU) No 255/2010 laying down common rules on air traffic flow management. It is expressed as the difference between the	Minutes per flights	Tactical – ground

[1] Reference to Performance Review Report 2014

[2] Reference to IR 390/2013

congestion in the EnRoute part and in the TMA part.			estimated take-off time requested by the aircraft operator in the last submitted flight plan and the calculated take-off time allocated by the central unit of ATFM.		

Determined Unit Cost for En-route ANS[1]

Definition	Comment	KPA	Formula	Unit	Delay
The en-route ANS Determined Unit Rate is defined as the en-route determined costs (in) divided by the total en-route service units.	The measure addresses the costs for the provision of en route air navigation services. The yearly values of the determined costs are fixed in advance, for the entire reference period. While monitoring performance, the en route actual unit cost (en route actual costs/actual en route service units) is compared against the determined unit rate.	Cost Efficiency	The indicator is the ratio between the en route determined costs and the en route forecast traffic, expressed in en-route service units, expected during the period at Union level.	expressed in euro and in real terms also expressed in nominal terms	N/A

Terminal ANS Unit Cost[1]

Definition	Comment	KPA	Formula	Unit	Delay
The terminal ANS Unit Cost is defined as the terminal costs (in real terms) divided by the total terminal service units	None	Cost Efficiency	the indicator is the result of the ratio between the determined costs and the forecast traffic, expressed in terminal service units	expressed in euro and in real terms also expressed in nominal terms	N/A

Cancellation[1]

Definition	Comment	KPA	Formula	Unit	Delay
In accordance with Regulation (EC) 691/2010, a flight is considered to be cancelled if the following conditions apply: – The flight received an airport slot; – The flight was confirmed by the air carrier the day before operations and/or it was contained in the daily list of flight schedules produced by the airport operator the day before operations; but, – The actual landing or take–off never occurred.	Flight cancelled due to ANS process	Capacity	Flight cancelled due to ANS process	Number of flights	N/A

In addition, the SDM introduces the CBA metric that is the result (in minutes for instance) of the performance indicator multiplied by the number of relevant flights. For example, the CBA metric "enroute ATFM delay" is the KPI "En Route ATFM delay" multiplied by the number of flights. The SDM would multiply the number of flights by a corrective factor of 50% if, for instance, it would only address arrival flights.

[1] Reference to Performance Review Report 2014

The CBA metrics is a parameter that can be easily monetized depending on the valorization reference (see chapter 2.2.3., Fig. 7). The following grid gives the CBA metrics used in relation to their KPAs.

KPAs	CBA metrics
Cost Efficiency	Savings linked to DUC[1] for en-route ANS
	Savings linked to Terminal ANS Unit Cost
Capacity	Airport ATFM Delay
	En-Route ATFM Delay
	Cancellations
Operational Efficiency	ATC Delay
	Unimpeded ASMA Time
	Additional ASMA Time
	Unimpeded Taxi-in Time
	Additional Taxi-in Time
	Unimpeded Taxi-out Time
	Additional Taxi-out Time
	Minutes related to fuel reduction
Environment	Savings linked to fuel consumption
	Savings linked to CO_2 reduction

Fig. 3: KPAs and CBA metrics

- In green, CBA metrics refer to "strategic" inefficiencies, for example due to airspace design, that is to say which refer to the reduction of delay that is included in airline schedules (flight plan).
- In blue, CBA metrics refer to "tactical" inefficiencies that is to say inefficiencies referring to the unpredictable delays on the day of operations that exceeds the delay buffer foreseen in the flight plan.
- In white, CBA metrics refer to additional savings of different nature.

Considerations for CBA metrics:

Nautical Miles:

Nautical Miles saved are not directly a CBA metrics but are translated in the following CBA metrics:

- "*Minutes related to fuel reduction*"
- "*Savings linked to fuel consumption*"
- "*Savings linked to CO2 reduction*" which refers to the reduced fuel burn.

Cost Efficiency:

The savings linked to DUC for en-route ANS and the savings linked to Terminal ANS Unit Cost cover the "ANS Gate-to-Gate Cost". Additionally, the SDM identified also savings on investment or running costs that have been monetized and related to cost efficiency.

Operational Efficiency:

The monetization of the CBA metrics (time in minutes) takes into account all the operational impact (for instance maintenance, crew…) including the cost of fuel.

Environment:

"Savings linked to fuel consumption" and "Saving linked to CO2 reduction" are used in CBA metrics to valorize projects that have an impact on environment.

Safety and Security are not developed with CBA metrics at this stage.

[1] DUC: Determined Unit Rate for en route Air Navigation Services: the measure addresses the costs for the provision of en route air navigation services. The en route ANS Determined Unit Rate is defined as the en route determined costs (in real terms) divided by the total en route service units. The yearly values of the determined costs are fixed in advance, for the entire reference period. While monitoring performance, the en route actual unit cost (en route actual costs/actual en route service units) is compared against the determined unit rate.

Additionally, the STAR tool includes the possibility for stakeholders to insert their assessments concerning predictability and resilience aspects, which may be of added value in the assessment of capacity or operational efficiency on the local situation and, consequently and possibly, at network level.

2.1.2. Initial Assessment approach

The initial assessment approach is as follows:

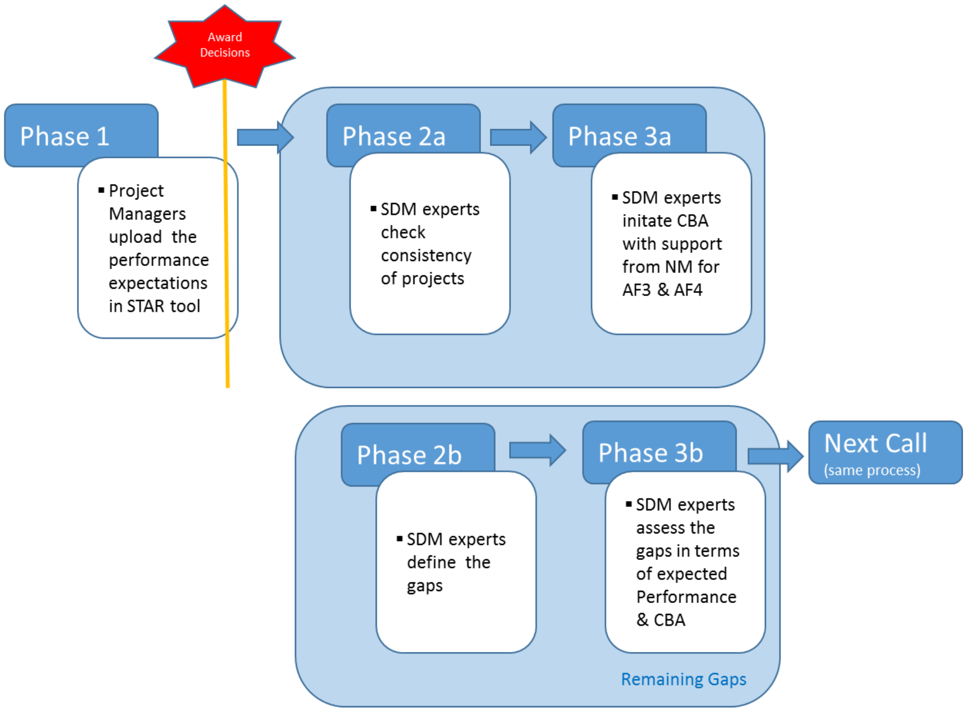

Fig. 4 – Identifying benefits

Phase 1

The information of the respective project allows collecting the initial information and expectations of benefits from the project managers for all projects before submission to the call. Information about expected performance improvements are based on the identification of improvements of Key Performance Areas (KPAs) and related information to support a quantitative analysis. The SDM relies on the projects information submitted by the project manager to identify the KPAs where benefits are expected.

Phase 2a

Once the projects awarded, the SDM reviews the qualitative information and the initial quantitative assessment where a percentage of improvement is mentioned or primary identified by the project manager or when other data are available. The SDM pays attention to the consistency of the data between projects, including the ones reported in NOP and ERNIP published by NM in accordance with EU IR 677/2011 as last amended.

Phase 2b

Once the projects awarded, the SDM identifies the remaining gaps comparing the awarded projects and the PCP.

Phase 3a

AF1 & AF2: SDM experts initiate CBA according to its top-down approach and share with the Project Manager (PM).

AF3 & AF4: SDM shares with the Network Manager to ensure consistency with the yearly-published Network Operations Plan and European Route Network Improvement Plan. The review takes into consideration a geographical perspective based on the projects included in the NOP and European Route Network Improvement Plan (ERNIP) and their agreed evaluation in terms of capacity and flight efficiency. It is to be noted that the evaluations made in the ERNIP are consistent, in relative terms, with the improvement required based on KPI on Environment that is based on the actual trajectory.

AF5 & AF6: SDM experts initiate CBA according to expert judgement and in accordance with the respective project managers.

Additionally, the SDM relies on the EDA to check whether the military impact was assessed. In any case, where questions have to be clarified, SDM requests the respective project managers for additional information.

Phase 3b

The SDM's experts also assess the expected benefits and costs of the remaining gaps.

2.2. Measuring expected benefits

2.2.1. Scope of Initial Costs and Benefits Analysis (CBA)

Starting point of elaboration of awarded projects is the question if this particular project is an independent or dependent to other projects. As a principle SDM is looking firstly to calculate independent CBAs.

Using the STAR tool to administrate all submitted and awarded projects, SDM is transferring every project in a so called thread[1]. This construction allows grouping of projects which are for instance:

- follow up projects (i.e. projects divided into phases)
- projects which are firstly enabler or prerequisites
- projects which are covering the same sub-family and therefore shall have the same impact on performance, in order to avoid double counting of benefits.
- projects not yet awarded which could fit in a thread bringing additional value. In this last case, the methodology allows to identify the missing projects (gaps), measure their expected additional value.
- projects dependent of other projects to deliver most of their benefits, or projects whose benefits cannot be isolated from other projects

In this cases the decision is to group the project with relevant other projects. This grouping is called a thread. It is based on the information included in the NOP and the ERNIP, whenever relevant. These threads shall be of the smallest possible dimension to generate tangible quantifiable benefits.

Whenever a grouping of single projects into threads is senseful, SDM will consult the respective project manager beforehand.

2.2.2. From KPAs to CBA metrics

The quantification of benefits is based on the estimation of improvement of Key Performance Areas compared with a baseline scenario. The estimation is assessed considering the relevant CBA metrics associated to the KPAs.

2.2.3. Process description

As a rule, it has been decided to calculate benefits comparing two decisions, "doing-nothing" or "project decision". There are two alternatives of measuring the benefits through the process, the "Bottom Up" approach and the "Top Down" one.

The two approaches are used systematically.

The "Bottom Up" approach is a way to associate the Project Manager and to measure the benefits in the most realistic way taking into account the context and the specificities of the project. It is time consuming and requires a good preparation to present an initial assessment that is fine-tuned according to the discussion. The SDM concludes on the final assessment and records the agreement or not of the Project Manager.

[1] Thread = smallest unit is a single Implementation Project (IP) or a multi project thread containing >1 IP.

The "Top Down" is used to make the initial assessment for the Bottom Up approach, and also to measure the benefits of the remaining gaps of the Deployment Programme.

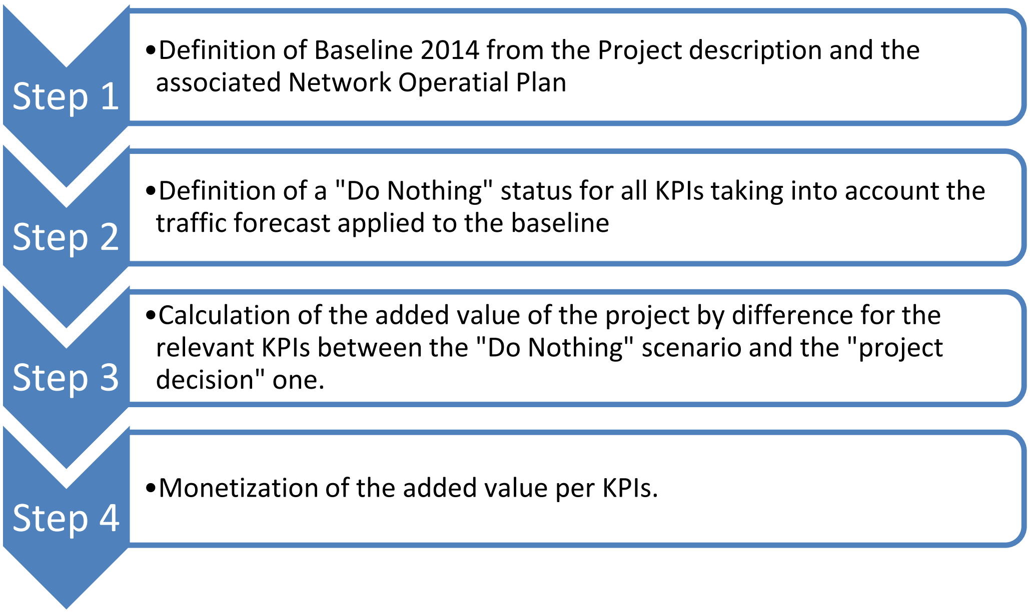

Fig. 5 – Measuring the expected benefits

The process in figure 5 is a systematic way to address any project or thread of projects in following four steps:

Step 1: Baseline 2014

Referring to the existing traffic situation in the area (airport, airspace) and using official public documentation such as the ones used by PRB or by NM, SDM generates the so-called "Baseline 2014".

The baseline 2014 describes the performance and traffic situation in 2014 of the geographical scope of the project (i.e. airport or airspace) within the Deployment Program. The base year is 2014 and the 2014 NOP/ERNIP or other relevant data define in principle this baseline.

Whether "Top Down" or "Bottom Up", this step is the same.

Step 2: "Do nothing" scenario

In order to build a "Do Nothing" scenario, the SDM needs to project the performance into the future according to the traffic forecast growth.

Concerning En-route airspace and TMA airspace, when applicable (AF3, AF4, AF5, AF6 projects), the NOP capacity assessment and planning process is the most validated and recognised methodology to project En-route ATFM delay (Capacity) and Flight Efficiency (Environment) performance into the future.

Concerning TMA or airports (AF1, AF2 projects), it is widely recognised that runway-related performance depends on variables which are factored in queuing formulae (runway utilisation, exposition to external events, traffic variability). However, each airport has its own specificities that prevent from using generic parameters. SDM seeks the support of each airport in defining the "Do Nothing" scenario. The input of the airport is then crosschecked with the NOP data. Concerning TMA capacity the "Do Nothing" scenario is elaborated on a case-by-case basis depending on the objectives of the project.

Finally, applied to all relevant KPIs, a "Do Nothing" performance evaluation is made based on the latest traffic forecast, which in nearly every case leads to an increase of delays and insufficient ATM results.

Step 3: Benefit as the difference between "Do-nothing" and "Project Decision"

The "Project Decision" scenario is qualified with an expected improvement level of the CBA metrics that, afterwards, is translated into the expected performance benefits.

Bottom Up approach

- The Project Manager and SDM discuss the assumptions to take for the relevant improvement levels with the Project Manager. SDM ensures consistency between the different similar projects or validates with the Network Manager according to the NOP/ERNIP documents when applicable.
- SDM considers the sensitivity of the project to deal with adverse weather conditions, resilience and robustness.
- TMA related projects would require a case-by-case assessment depending on:
  - whether contribution is mainly directed to improve the runway queuing at a given airport, then the TMA related project could be combined with AF1 and AF2 projects at that airport.
  - whether contribution is mainly directed to improve the TMA capability to handle multiple queuing at different airports; then the TMA related project is treated separately.
  - whether contribution is mainly directed to improve the ATC sector capacity; then the TMA related project is considered in the appropriate en-route / network AFs.

Top Down approach

- For AF1 and AF2, the SDM has defined improvement percentages (see Fig. 5), for each family and each relevant CBA metric, based on different sources: SJU SESAR Deliverables, Flights Demo Reports, Expert judgement….
- The benefits are then calculated on a yearly basis as:

$$YB = \%I \times CBA \times VEUR$$ [1]

The yearly benefit is then used to calculate a total undiscounted or discounted benefit on the reference period (2014-2030) according to an assumption of ramp-up over time (how the benefits progressively reach 100% of the yearly benefit). Top-down AF1 and AF2 improvement assumptions are defined by family and performance indicator:

Improvement assumptions per family and performance indicator	AF1							AF2								
	1.1.1- Basic AMAN	1.1.2 – E-AMAN	1.2.1 - RNP APCH with vert. guid.	1.2.2 - Geo. DB for procedure design	1.2.3 - RNP1 (ground capa.)	1.2.4 - RNP1 (aircraft capa)	1.2.5 - A-RNP below FL310	2.1.1 - Initial DMAN	2.1.2 - Elec. Flt Strips	2.1.3 - Basic A-CDM	2.1.4 - Initial Apt Op. Plan	2.2.1 - A-SMGCS Level 1&2	2.3.1 - Time-based Separation	2.4.1 - A-SMGCS Routing & Planning	2.5.1 – Apt. Safety Net with A-SMGCS	2.5.2 - Aircraft & vehicle systems
Unimpeded time in ASMA	1.5%	1.5%	1.5%		3.0%		1.5%						0.3%			
Additional time in ASMA	0.5%	0.5%	1.5%		3.0%		1.5%				0.1%		16.7%			
Airport ATFM Delay	0.5%	0.5%									0.3%		8.3%			
Additional time in taxi-in											0.1%	0.5%		0.5%		
Unimpeded time in taxi-out								0.3%	0.3%	0.3%	0.6%			0.3%		
Additional time in taxi-out								3.0%	1.0%	3.0%	3.0%	0.5%		0.4%		
ATC Delay								0.3%	0.3%	0.3%	0.3%	0.5%		0.5%		
Terminal ANS Cost								0.3%	0.3%	0.3%	0.3%	0.5%		0.3%		
KEA																
ER ATFM Delays	0.0%	0.0%														
EnRoute DUC																
Operational Cancellations								10%		10%	20%					
Correction factors																
Unimpeded time in ASMA	50%	50%	50%		50%		50%						3%			
Additional time in ASMA	50%	50%	50%		50%		50%				50%		3%			
Airport ATFM Delay	50%	50%									50%		3%			
Additional time in taxi-in											50%	50%		50%		
Unimpeded time in taxi-out								50%	50%	50%	50%	50%		50%		
Additional time in taxi-out								50%	50%	50%	50%	50%		50%		
ATC Delay								50%	50%	50%	50%	50%		50%		
Terminal ANS Cost								50%	50%	50%	50%	50%		50%		
KEA																
ER ATFM Delays	50%	50%														
EnRoute DUC																
Operational Cancellations								1.5%		1.5%	1.5%					

Fig. 6 – Improvement assumptions

For AF3 and AF4 the assessments made by the Network Manager take into consideration a harmonised network approach. The Network Manager ensures the consistency between the Network Operations Plan, the European Route Network Improvement Plan Part 2 and the relevant projects proposed in the context of the AF3 and AF4. This consistency must be maintained for all the subsequent updates of the Deployment Programme and the gaps identification.

[1] YB = yearly benefit, %I = percentage of improvement, CBA = CBA metric, VEUR = valorisation in Euros.

Capacity Assessment with respect to the AF3 and AF4 projects:

- The capacity assessment is based on the Capacity Assessment and Planning Guidance document that has been approved by the Network Manager Board in June 2013, as part of the Network Operations Plan Approval. The reference to this document is given in all the successive editions of the Network Operations Plan.
- In the capacity assessment, the percentages of improvement brought by the project or thread are taken into account together with the flight profiles derived from STATFOR data assuming routing via the shortest routes available on the future ATS route network, with generally unconstrained vertical profiles. (in general the base scenario from STATFOR is used and with an homogenous approach following impacts are considered: reduction of nautical miles and saving of En Route ATFM delays).
- The Network Manager has ensured a full consistency between the last available version of the Network Operations Plan and the evaluation of the operational performance potential of the AF3 and AF4 projects. This potential is covered either by the projects proposed by various operational stakeholders as part of the CEF Call or is included in the gap analysis.
- The Network Manager developed a do-nothing scenario that was then compared to the potential of the various AF3 and AF4 related projects listed in the last available version of the Network Operations Plan. The assessments take into consideration a harmonized network approach.

Flight Efficiency with respect to the AF3 and AF4 projects:

- The flight efficiency assessment is based on the overall flight efficiency evaluations made in the context of the last version of the European Route Network Improvement Plan, Part 2 – ARN Version.
- The Network Manager has ensured a full consistency between the European Route Network Improvement Plan, Part 2 last ARN version and the evaluation of the operational performance potential of the AF3 and AF4 projects with respect to flight efficiency. This potential is covered either by the projects proposed by various operational stakeholders as part of the CEF Call 2014 or is included in the gap analysis.
- The evaluations made in the previous editions of the European Route Network Improvement Plan, Part 2 demonstrated that the operational performance improvements achieved were in line year on year with the estimations made.

Step 4: Monetization of Benefits

To facilitate the monitoring and comparison with the PCP CBA published in 2013 as the reference and supporting material to the regulation (EC) 716/2014, SDM decided to use the same metrics or at least aligned ones.

Considering the long timeframe (2014-2030), it seems also a reasonable choice.

It is therefore understood that SDM does not plan to review these assumptions unless mandated by the European Commission, within a new context such as the review of the PCP regulation, and in order to support specific decisions. This review would then be shared with SJU.

The performance differences are monetized through a set of values defined as follows:

Cost-Assumptions		
ATC delay ATFM delay (ER, Airport, TMA)	Tactical Ground Delay	28€/minute[2]
ASMA (add. Time) Taxi Out (add. Time)	Tactical Airborne Delay	44€/minute[2]
ASMA (unimpeded) Taxi In/Out (unimpeded)	Strategic airborne Delay	50€/minute[1]
Flight Time Reduction	Airborne Strategic Cost	31€/minute[1]

Fuel	Kg	0,79€ (2014)[1]
CO_2[1]	T	4,30€ (2014)[1]
Flight cancelled		7.600€[3]

1. REFERENCE AND SUPPORTING MATERIAL – (EC) NO 716-2014 Art.4(c) Global cost benefit analysis. Part B. Assumption, Chapter 9.
2. REFERENCE AND SUPPORTING MATERIAL – (EC) NO 716-2014 Art.4(c) Global cost benefit analysis. Part B. Assumption, Chapter 9.with values calculated with a 70/30 (low/high cost assumptions) ratio
3. Eurocontrol Standard Inputs, Ed.6 para. "Cancellation Cost", chapter 4

Fig. 7 – Cost assumptions

As explained under the figure 1 of the document, savings linked to tactical delays and strategic delays are referred to in reference to the flight plan, respectively reducing the delays exceeding the buffer foreseen or reducing the overall plan itself.

The cost of tactical delays is used for instance for:
- ATFM delays (ER, Airport, TMA)
- ATC delays
- Additional Time (in taxiing & in ASMA)

The cost of strategic delays is used for instance for:
- Unimpeded time (in taxiing & in ASMA)

Explanation of the 28€/min and 44€/min in the first two lines of the figure 7:

SDM is taking different values depending on airborne or ground related metrics with an assumption on the cost categories of 70% low and 30% high.

- Ground Tactical delays [23.8€-37.7€] => 28€
- Airborne Tactical delays [39.4€-53.3€] => 44€

2.2.4. Data source

The SDM uses published data when possible, or sources consistent with the one used for PCP CBA, the ATM Master Plan and the SES high-level goals.

Performance Indicators:

- CAPA per Airport : Eurocontrol dashboard download area, "Arrival Sequencing and Metering (ASMA) additional time", "Airport arrival ATFM delays", Taxi out additional time - JAN-FEB 2015 - Source: PRR 2014 p 65 (graph) and p63 (graph)
  - http://www.eurocontrol.int/prudata/dashboard/downloads.html
- CAPA per Country : Eurocontrol dashboard, download area - "En route ATFM delays" Jan 2015
  - http://www.eurocontrol.int/prudata/dashboard/eur_view_2014.html
- Flight Efficiency : PRR 2014 p45 (graph)
  - http://www.eurocontrol.int/sites/default/files/publication/files/prr-2014.PDF
- ANS Cost Efficiency : Eurocontrol Dashboard Local view, "En route Determined Unit Rate (DUR) KPI [real terms; 2009 prices] & En route (ER) service units (SU)" & "Terminal (TR) ANS cost PI [national currency] & Inflation rates" tables (from National/FAB performance plans) - FEB 2015
  - http://www.eurocontrol.int/prudata/dashboard/pp_view_2014.html
- Resilience : PRR 2014, P54 (from PRU[2] analysis; Central Office for Delay Analysis -CODA[3])
  - http://www.eurocontrol.int/sites/default/files/publication/files/prr-2014.PDF

[1] The index for CO_2 is 3.149 Kg/Kg fuel burned.
[2] PRU: Performance Review Unit
[3] CODA: Central Office of delay Analysis

For the "Bottom Up" approach, the SDM shares its information with the Project Manager while preparing the CBA. The stakeholders (e.g. Central Office for Delay Analysis - CODA) can also provide directly some data.

2.3. Monitoring benefits

As some assumptions may change over time or deviation in traffic evolution or other reference data may occur, SDM continuously monitors the benefits of all awarded projects based on the CEF Calls. On the course of the implementation, assumptions may be reviewed and yearly updates of data sources are used by the SDM.

In addition, the SDM is expected to monitor the benefits until the change is operational: the final target is the measurement of actual benefits of the thread when fully implemented. Specific analysis might be necessary to implement the methodology on this topic.

Therefore, the two main streams of action are as follows:

- Monitoring: SDM intends to monitor and to confirm all prior assumptions, data comparison and results of theoretical simulations done by SDM, NM or Project Manager. This includes for instance a continuously updating of PRU and CODA data on relevant KPIs.
- Performance Crosscheck: A final performance monitoring set is established to support a real life crosscheck done by SDM with support of Airspace Users, ANSPs and Airports demonstrating that key drivers of deployment have been reached and the SESAR Deployment has been accomplished. Therefore, a manageable frame of actions will be needed. SDM suggests organizing part time real life crosschecks, whenever reasonable working packages have been finalized. (for instance comparison of FRA-DCT projects according fuel burn and flight time with historic data).

2.4. Estimating accuracy of benefits

Accuracy of benefits is based depending on the project, either on specific assumptions, or, based on NM tools. The CBA always describes the assumptions taken.

For instance, and when applicable, the results of delays forecast at FAB/ANSP/ACC level as published in the Network Operations Plan (NOP) are taken on board. Also in these cases, the route length extension analysis figures published in the European Route Network Improvement Plan (ERNIP) for the calculation of the flight efficiency benefits are used.

The results used in NOP and ERNIP have proved to be quite accurate in the recent years and are closely monitored every year through reporting and consultation with the concerned operational stakeholders in the NM cooperative decision-making arrangements.

Valuable information is coming from the project managers bringing an operational understanding of their project that is scrutinized by the SDM: contextual performance information collected through the project template, evaluation of the operational conditions and dependencies of the project, validation of the consistency with the NOP information, military impact if any.

It is expected that this accuracy improves, as the experience on project performance assessment is capitalised over time.

3. Costs

3.1. Identifying costs

The estimated budget is reported in the Annex of the SGA1. The costs are updated continuously by the Action beneficiaries. As a pre-condition the eligibility of costs is outlined in Article II.19.1 of the FPA.

As the CBA focuses on awarded projects, other costs, either related but not provided or spent without funding, are not taken into account. However, it is expected to furthermore establish an approach to embrace also the cost of projects which are not funded.

[1] SGA = Specific Grant Agreement

3.2. Measuring expected costs

Costs are measured according to the level of detail uploaded by the project manager in the STAR tool and according to the provisions of the ICA, SGA and FPA.

3.3. Monitoring of costs

SDM tracks costs in accordance with the estimated budget and the development of the expenditures in the duration of the respective Action.

3.4. Cost Effectiveness Analysis (CEA)

The SDM makes the cost effectiveness analysis of the Implementation Projects when those are submitted to be included in a proposal coordinated by the SDM as requested by INEA and independently from the technical prioritization. As contributing to the implementation of the Pilot Common Project (PCP), the projects shall demonstrate effectiveness against the PCP CBA. The Pilot Common Project is subject to the EU Regulation ref. (EU) 716/2014 that has been adopted on the basis of an overall positive Cost Benefit Analysis (article 4.c and associated supporting material).

The cost effectiveness analysis aims at measuring how much every Implementation Project fits within the expected envelope.

The methodology allows assessing that the cost of a project is proportionate to the benefits expected from this project in the framework of PCP implementation.

In order to assess the **Effectiveness (E)** of a project, its **Cost of project (CP)**, as provided by the implementing partner, is compared to the **Gap Reference Cost (GRC)** of the gap in the DP that the project contributes to cover by a certain percentage which is called the **Gap Coverage (GC)**. The formula below applies:

$$E = GRC * \frac{GC}{CP}$$

Step by step

Estimation of E for each project requires six steps.

Step 1: Gap Yearly Benefit (GYB)

This step is performed for each gap as explained in STEP3 of the chapter 2.2.3. It is project neutral.

Step 2: Cumulated Gap Benefit (CGB)

This step is performed for each gap. It is project neutral. The total benefit expected from a gap is calculated from GYB modulated by a ramp-up over the payback period. Unless defined otherwise in the DP, the ramp-up is given by PCP's CBA. It is the ramp-up of the AF to which this gap belongs.

Unless defined otherwise in the DP, the payback period is given by PCP's CBA. It is the payback period of the AF to which this gap belongs. The calculation takes into account the discounted values of money for future years according to the PCP CBA reference value of 8% of discounted rate[1]. GYB is discounted and modulated each year to sum the global benefit on the payback period.

Step 3: Gap Reference Cost (GRC)

This step is performed for each gap and it is project neutral. This step aims at estimating a GRC for a gap identified in the DP. The GRC is estimated on the basis of a reference as provided by PCP CBA, either the benefits expected for the AF 1 to 4 (excluding families 2.5) according to the payback period or, the cost envelope of the AF 5 and 6 and families 2.5, to which this gap relates.

Some assumptions are used to adjust the specificities of some gaps:

- AF1 RNP approach: Data Base for Procedure Design (family 1.2.2) have been accommodated a 5% overall of AF1.2 families benefits and Airspace Users gap (family 1.2.4) a 15%.

[1] Discount Rate of 8% according to the value published in PCP EC-716-2014 article 4c global CBA.

- AF Safety Net (families 2.5.1 and 2.5.2) are not providing quantified benefits. This cost is then analysed according to the cost reference of the PCP CBA.

The breakdown of the total AF related PCP reference between all the gaps in all the families for this AF is performed according to a distribution key.

The key is calculated as follows:

- All the CGB of all the gaps in the same AF are added.
- Each CGB is then expressed as a percentage of this total. The sum of CGB percentages is equal to 100;

The GRC of each gap is then obtained by multiplying the percentage of the gap by the total cost of the AF as provided by PCP CBA. The GRC is the maximum budget available to close the gap while complying with PCP CBA.

Step 4: Effectiveness (E)

This step is specific for every thread (single IP thread or multiple IP thread). The thread cost is the sum of the projects of the thread.

It connects the thread cost (CP, in €) with the GRC of the gap it contributes to (in €, see step 3) taking into account the percentage by which the thread closes the gap, named the Gap Coverage: GC (in %). GC is evaluated by SDM.

This GC is a collegial experts' judgment reviewed and harmonized at SDM level. It is defined roughly as 20%, 50%, 80% or 100%. The way of judging gap coverage has been established in a pragmatic way. The experts would first judge clearly if the project does cover 100% of the gap or not (meaning other projects would be needed to implement the functionality on the defined scope). Then, the experts would appreciate according to the content of the project, how much the coverage is, more or less than 50% or eventually 50%. For specific situations such as gaps shared between airlines, the percentage of flights flown by the airlines of the project to the PCP airports would be an additional criterion.

Step 5: Sensibility analysis

As shown by the formula, impact on the **Effectiveness (E)** relies on the three different contributors (GRC, GC and CP). The formula protects the global consistency with the PCP CBA at ATM functionality level (AF). As explained previously, some projects may be grouped in threads to better fit a gap or eventually several gaps. In this case the E value would be the same for all the grouped projects.

The results are provided through a **"Cost Effectiveness Indicator"** whose absolute value is then translated into a five-level color scale:

- "Green" (G) when the cost effectiveness is 0.9 or above. The cost is below 1.11 times the reference (GRC*GC);
- "Light Green" (LG) when the cost effectiveness is between 0.5 and 0.9. The cost is between 2 times and 1.11 times the reference (GRC*GC);
- "Yellow" (Y) when the cost effectiveness is between 0.1 and 0.5. The cost is between 2 and 10 times the reference (GRC*GC);
- "Orange" (O) when the cost effectiveness is between 0.01 and 0.1. The cost is between 10 and 100 times the reference (GRC*GC);
- "Violet" (V) when the cost effectiveness is 0.01 or below. The cost is above 100 times the reference budget (GRC*GC).

Due to the methodology used, SDM considers that a group of IPs is more cost effective when its CEA indicator is Green and Light Green, and less cost effective when it is Yellow or even much less when it is Orange. Violet clearly indicates a non-sufficient cost effectiveness.

Step 6: Mathematical Interpretation

- When E is close to 1, it means that the cost for closing the gap equals the expected contribution to benefits. Cost effectiveness is aligned with PCP CBA;
- When E is lower than 1, it means that the cost for closing the gap is above the expected contribution to benefits. It is sub-effective compared with PCP CBA;

- When E is higher than 1, it means that the cost for closing the gap is below the expected contribution to benefits. It is over-effective compared with PCP CBA.

3.5. Estimating accuracy of costs

Accuracy of costs is linked to the accuracy of the declared costs by the project managers.

4. Analysing costs and benefits

4.1. Net Present Value (NPV)

The SDM deducts costs from the monetary benefits to compute the expected NPV per thread of projects. The discount rate is kept at 8% to be consistent with the "REFERENCE AND SUPPORTING MATERIAL – (EC) NO 716-2014 Art.4(c) Global cost benefit analysis".

For each thread of projects, the STAR tool allows to present the results of NPV over a 10 year-period. It also calculates the payback period.

4.2. Analysis on costs and benefits results

SDM shares the information on the CBA results with the Implementing Partners through the STAR tool.

The results present the expected benefits monetized and the associated costs. Those projects that depend on future projects to realize benefits are candidates for multi-project threads in the STAR tool.

SDM shall integrate its analysis in the "Monitoring & Performance view" of the Deployment Programme. It should also support the evaluation of the contribution of the Deployment Program to the SES high-level goals. In a more detailed manner, it should also identify risks from the outcome of some projects.

The global CBA is the CBA summing all CBAs of the Deployment Programme for all awarded projects and threads. This global CBA shall be regularly published in the "Monitoring & Performance view" of the Deployment Program and will mature over time to reflect the full scope of Regulation (EU) n. 716/2014.

4.3. Comparing with the PCP CBA

The initial reference for the PCP is the PCP CBA referred to in EU Regulation 716/2014, article 4 – c). The global CBA is then compared to this reference to assess any significant deviation.

It is understood that the initial PCP CBA has been calculated based on many assumptions and the analysis shall review the main changes in these assumptions to explain the differences. The differences with the initial PCP CBA supporting the PCP implementing Regulation shall be analysed by SDM with the SJU in view of identifying lessons to be learned and improving the CBA methodology to support the setting up of the next CPs.

Finally, the main conclusions of this analysis shall be reported to the European Commission.

As an example of different assumptions:

- PCP CBA uses percentages of delayed flights and durations of delays and so uses a global figure of mixed ground and airborne activities. PCP CBA makes the assumption of 90% ground delays and 10% airborne delays.
- SDM has the opportunity to be more precise in the CBA due the Performance Indicators used (related to SES II and Performance Scheme, e.g. ATFM delays, Additional time, etc.). So SDM can use the exact cost of airborne delays and of ground delays (this avoids using a mixed value of 90% grounded and 10% airborne delays).
- PCP CBA takes into account the cost for the deployment of the functionalities of the PCP. The PCP CBA however does not reflect the necessary prerequisites and enablers in need of deployment in order to establish the operational or technical capability / baseline to implement the PCP functionalities. The European Commission has however acknowledged that CEF funding shall also be used to secure the necessary investment of prerequisites and enablers. Therewith the total cost of the awarded IPs not being comparable on a one-to-one basis to the original assessments of the PCP CBA.

4.4. Cross reading of Performance Indicators with the SES II Performance Scheme and the ATM Master Plan.

The table below presents the consistency between the indicators used by the SDM and the other relevant European references (SES II Performance scheme and ATM Master Plan).

SDM Performance Indicators	KPI SES II Performance Scheme	KPI ATM Master Plan
Airports ATFM delays	Arrival Airports ATFM delays	Departure delay
ATC delay	ATC pre-departure delay	Departure Delay
Unimpeded taxi-out time	Unimpeded taxi-out time	Flight Time
Additional taxi-out time	Additional taxi-out time	Flight Time
Unimpeded time in taxi-in	Not in the IR but it is the counterpart of Unimpeded time in taxi-out but in the arrival phase	Flight Time
Additional time in taxi-in	Not in the IR but it is the counterpart of Unimpeded time in taxi-out but in the arrival phase	Flight Time
Unimpeded ASMA time	Unimpeded ASMA time	Flight Time
Additional ASMA time	Additional ASMA time	Flight Time
en route ATFM delay	en route ATFM delay	Departure delay
Determined Unit Cost for en-route ANS	Determined Unit Cost for en-route ANS	gate to gate direct ANS costs per flight
Terminal ANS Unit Cost	Determined Unit Cost for Terminal ANS	gate to gate direct ANS costs per flight
Cancellation		Additional flights at congested airports and Additional flights at network level

Fig. 8 – SDM Performance Indicators,
SES II Performance Scheme KPIs and ATM Master Plan KPIs

The figure shows that SESAR indicators, whether in the column "SDM Performance Indicators" or the "KPI ATM Master Plan" one, are either equivalent or cross-readable with the "KPI SES II Performance scheme" column. Being implementation and deployment oriented, the SDM Performance Indicators are matching the SES II Performance scheme.

The reconciliation of the "SDM Performance Indicators" with the Performance Scheme or the ATM Master Plan is possible thanks to the granularity of SDM's CBA metrics. For instance, instead of assessing additional capacity measured in additional flights, the CBA calculates time reduction, which can also be transposed into additional flights, in line with the ATM Master Plan KPI.