EPISODE 3

Single European Sky Implementation support through Validation

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DOCUMENT CONTROL

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EXECUTIVE SUMMARY

The objective of Episode 3 Work Package 2.4.1 (EP3 WP2.4.1) is to provide a methodology for future assessment of the SESAR concept on a 2020 ECAC wide basis as no such model currently exists.

This methodology allows the aggregation of validation measurements of different levels of granularity, e.g. local versus regional, and uncertainty, e.g. expert judgement versus simulation. The methodology is based on:

- An understanding of the elements that contribute and influence the performance (For more info see the annex II and the Influence diagrams document);
- An ECAC Model that represents the elements that are linked and the mechanism to combine their influences. (For more info see annex II and the Influence model developed with Analytica, an example of input data to the model and the User Manual documents);
- The definition of a catalogue of common Performance Indicators (PIs) as references to ensure consistency and capture data about the influencing factors from exercises, expert group, current and past studies (For more info see the annex III and the Catalogue of Performance Indicators document).

The common references defined in this catalogue of PIs will be used by the validation exercises contributing to the quantification of the performances. It provides "WHAT" will be measured.

The EP3 WP 2.4.1 Performance Framework has further developed six of the SESAR's Key Performance Areas (KPAs):

- Capacity;
- Efficiency;
- Flexibility;
- Predictability;
- Safety;
- Environment.

The EP3 improvement to the SESAR influence diagrams work includes a wider coverage of the KPA and the use of a decision support tool that ensures consistency between the influence diagrams and the model and allows diagrams to be presented at different levels of detail.

The EP3 WP 2.4.1 Performance Framework has defined different layers of performance indicators according to the performance areas. The catalogue of PIs is divided into three layers:

- ECAC wide;
- ECAC Airport, TMA, En-route;
- Local Performance Indicators for Airport, TMA and En-route.

The EP3 validation exercises are expected to use these Performance Indicators however new Performance Indicators could be included in the course of the project. In case where the exercises use metrics not in this catalogue, they are responsible for providing an integration process to feed the ECAC model.

1 INTRODUCTION

1.1 BACKGROUND

The Episode 3 (EP3) objective is to clarify and provide initial validation results for the SESAR Operational Concept. The project will bridge the gap between the SESAR definition phase and the SESAR development phase under the management of the SESAR Joint Undertaking (SJU).

The SESAR rationale is to achieve specified performance targets. Therefore there is a need to better quantify the benefits and performance variability of the SESAR Operational Concept, characterised by a set of Operational Improvements (OIs), against these targets.

The EP3 Performance Framework (PF) is aligned with SESAR through the previous work from the SESAR definition phase. This alignment is strengthened by the continued participation of the SESAR team on the EP3 task.

The EP3 WP2.4.1 Performance Framework has used D2 of SESAR, *Air Transport Framework* [9] that presents the full set of SESAR's eleven Key Performance Areas as its main source of information. SESAR has revised these targets and delivered a new version of the SESAR performance objectives and targets in the document SESAR Performance Booklet [8] . This document has also been taken into account during the development of the Performance Indicators.

The SESAR D2 is aligned with the guidance material contained in the *ICAO Global Performance Manual (GPM)* [13]. The ICAO GPM guidance material is equally relevant to the future development of the EP3 Performance Framework.

The influence diagrams developed in SESAR D3 *The ATM Target Concept* [17] and in D4*, The ATM Deployment Sequence* [15], were used as a starting point to build the relationships among the different layers of Performance Indicators and Key Performance Areas. The EP3 influence diagrams were developed during 2008.

1.2 PURPOSE OF THE DOCUMENT

This document sets out the initial structure and objectives of a Performance Framework to be used within the EP3 project. The Performance Framework is a key document that provides a catalogue of metrics to be used by the validation exercises to allow a meaningful "ECAC picture" to be built. This will determine "WHAT" will be measured and thus the contribution the relevant Operational Improvements are likely to make to the achievement of the targets set out in SESAR D2.

The framework consists of a set of key performance metrics and the links between Performance Indicators of different characteristics levels. The set key performance metrics are grouped against three performance levels:

- ECAC-wide;
- 4 categories of ATM operation; and
- Local Airport and ACC operation.

The Performance Framework provides a common reference for the measurements that are performed by the EP3 Work Package 3 (WP3), *Collaborative Planning Processes* WP4, *En-route and Traffic Management* and WP5, *TMA and Airport* validation exercises.

The Performance Framework is part of the overall Validation Framework developed by EP3 WP2. It provides a higher-level view based on an optimisation of the system across a broader set of aspects than just operational performance. It covers aspects associated with Procedural, Human, Technological, and Institutional enablers. In this context, the Validation

Framework provided the system level validation requirements for the present Performance Framework, see Annex I. In total, the overall Validation Framework will be composed of the following elements:

- The Performance Framework (this document) detailing "WHAT" to measure;
- A set of scenarios providing coverage of the different contexts to which aspects of the CONOPS [11] are applicable – i.e. "WHEN" and "WHERE" to measure;
- A set of measurement strategies & practices, calibration references and techniques – i.e. "HOW" to measure.

The current Version 3 of the Performance Framework has evolved from the first version to adapt its scope to the new DoW v3.0 [5]. This version also includes the approach in Episode 3 to the Environment KPA, and a refinement in the description of the methodology and a total overview of the Influence Diagrams, the Influence Model and its user manual.

1.3 INTENDED AUDIENCE

The intended audience includes:

- EP3 partners;
- SESAR community.

1.4 DOCUMENT STRUCTURE

The document is structured in four main parts. The first describes the general objectives of the Performance Framework and how the general approach has been designed (chapters 1, 2 and Annex I). The second part gives the Influence Diagram which will be used in the Performance Framework in order to describe and eventually quantify the relationships between the factors that affect the performance (Chapter 3 and Annex II). The third part presents the methodology implemented by the performance framework allowing evaluation of the ECAC wide performance (chapter 4). It includes examples of the application of this methodology. Finally the fourth part describes a catalogue of Performance Indicators to be used for measurement and integration of the results from the validation exercises (Chapter 5 and Annexes III and IV).

1.5 GLOSSARY OF TERMS

1.5.1 Definitions

Term	Definition
Airport, TMA, En-route ECAC Performance Indicator	**The Airport, TMA, En-route ECAC layer** are a sub part of the ECAC wide Performance Indicator. They address the ECAC wide performance of all Airports, TMA and En-route of an OI or a group of OIs. For example this can be the influence of group of OIs on the fuel consumption for all the ECAC airports.
Airport	A defined area on land or water (including buildings, installations and equipment) intended to be used either wholly or in part for the arrival, departure and surface movement of aircraft.[1]

[1] EATMP glossary

Term	Definition
ATM Network	Airspace structure (airport nodes linked together by airspace volumes e.g. sectors and routes) and technical infrastructure network (aircraft, ground systems, communication network, etc…) supporting the management of air traffic.
ECAC Performance Indicator	**The ECAC wide Performance Indicator layer** addresses the ECAC wide picture of the performance. For example this can be the ECAC (Airport + TMA + En-route) fuel consumption, CO_2 emission or delay.
En-route or ER	A defined area that is neither TMA nor airport.[2]
Focus Area	Focus Area Within each KPA a number of more specific areas — Focus Areas — are identified in which there are potential intentions to establish performance management. Focus Areas are typically needed where performance issues have been identified. For example, within the Capacity KPA one can identify airport capacity, runway capacity and apron capacity as Focus Areas. Within the Safety KPA, the list of Focus Areas might include: accidents, incidents, mid-air collisions, CFIT accidents, runway incursions, safety management system maturity, etc.
KPA	Key Performance Areas are a way of categorising performance subjects related to high level ambitions and expectations. ICAO has defined 11 KPAs: safety, security, environmental impact, cost effectiveness, capacity, flight efficiency, flexibility, predictability, access and equity, participation and collaboration, interoperability.
Local Performance Indicator	**The Local PIs layer** for Airport, TMA and En-route represents a sub part of the Airport, TMA or En-Route ECAC Performance Indicator to a local indicator. This addresses the local performance of an OI or a group of OIs. This can be the influence of group of OIs on the fuel consumption for a specific airport assessed by the validation exercise For example but then it will be needed to develop a methodology to extrapolate such result in order to obtain a value at ECAC level.
Metrics	Supporting metrics are used to calculate the values of performance indicators. For example cost-per-flight-indicator = Sum(cost)/Sum(flights). Performance measurement is done through the collection of data for the supporting metrics (e.g. this leads to a requirement for cost data collection and flight data collection).
Performance Indicator (PI)	Current/past performance, expected future performance (estimated as part of forecasting and performance modelling), as well as actual progress in achieving performance objectives is quantitatively expressed by means of indicators (sometimes called Key Performance Indicators, or KPIs). To be relevant, indicators need to correctly express the intention of the associated performance objective. Since indicators support objectives, they should not be defined without having a specific performance objective in mind. Indicators are not often directly measured. They are calculated from supporting metrics according to clearly defined formulas, e.g. cost-per-flight-indicator = Sum (cost)/Sum(flights). Performance measurement is therefore done through the collection of data for the supporting metrics.
Performance Target (PT)	Performance targets are closely associated with performance indicators: they represent the values of performance indicators that need to be reached or exceeded to consider a performance objective as being fully achieved.

[2] EP3 definition

Term	Definition
SESAR	The SESAR project (formerly known as SESAME) is the European air traffic control infrastructure modernisation programme. SESAR aims at developing the new generation air traffic management system capable of ensuring the safety and fluidity of air transport worldwide over the next 30 years.
TMA	A control area normally established at the confluence of ATS routes in the vicinity of one or more major aerodromes.[3] For consistency and convenience for performance aggregation of the measurement within the ECAC model there was a need to have a numerical representation. There is work ongoing in PRC to revise the current 30NM radius to probably 100NM as in US. Given that EP3 is considering a 100NM that will allow capturing most of the benefit in the TMA.
Uncertainty	In statistics, an **uncertainty** is not a “mistake” but is a difference between a computed, estimated, or measured value and the true, specified, or theoretically correct value.

Table 1-1 Glossary of definitions

1.5.2 Acronyms

Term	Definition
ACC	Area Control Centre
AIS	Aeronautical Information System
ANS	Air Navigation System
APU	Auxiliary Power Unit
ASM	Airspace Management
ATCO	Air Traffic Controller
ATFCM	Air Traffic Flow and Capacity Management
ATM	Air Traffic Management
BDT	Business Development Trajectory
BIC	Best in Class
CDA	Continuous Descendent Approach
CFIT	Controlled Flight Into Terrain
CONOPS	Concept of Operations
CNS	Communication Navigation Surveillance
CSBT	Coordinated Shared Business Trajectory
EC	European Commission
ECAC	European Civil Aviation Conference
E-OCVM	European Operational Concept Validation Methodology
ER	En-route
EP3	Episode 3

[3] EATMP glossary

Term	Definition
ERC	EUROCONTROL
ESARR	EUROCONTROL Safety Regulation Requirements
GHG	Green House Gas emissions
GPM	Global Performance Manual
HC	Hydrocarbons
ICAO	Internationale Civil Aviation Organisation
ID	Influence Diagram
IFR	Instrumental Flight Rules
IM	Influence model
IMC	Instrumental Meteorological Conditions
ISBT	Initial Shared Business Trajectory
KPA	Key Performance Area
LoC	Lines of Change
LTO	Landing and Take-Off
MTOW	Maximum Take Off Weight
OACI	Organisation de l'Aviation Civile Internationale
OCE	Operational Concept Element
OI	Operational Improvement
PF	Performance Framework
PI	Performance Indicator
PM	Particulate Matter
PRR	Performance Review Report
PT	Performance Target
QoS	Quality of Service
RBT	Reference Business Trajectory
ROT	Runway Occupancy Time
SBT	Shared Business Trajectory
SESAR	Single European Sky ATM Research
SID	Standard Instrument Departure
STAR	Standard Terminal Arrival Route
STCA	Short Term Conflict Alert
TMA	Terminal and Manoeuvring Area
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions *
VOC	Volatile Organic Compounds

Table 1-2 Glossary of Acronyms

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2 EP3 PERFORMANCE FRAMEWORK LAYERS

The global Performance Framework is based on the definition of SESAR KPAs, Focus Areas and Performance Indicators and the influence that the Operational Concept will have on them. The Performance Framework is composed of KPAs, Focus Areas and performance indicator layers, as shown in figure below. A common approach to integrate the results coming from the exercises is described in the scheme shown below. For more information related to the integration of exercise results, see section 4 Performance Framework Methodology.

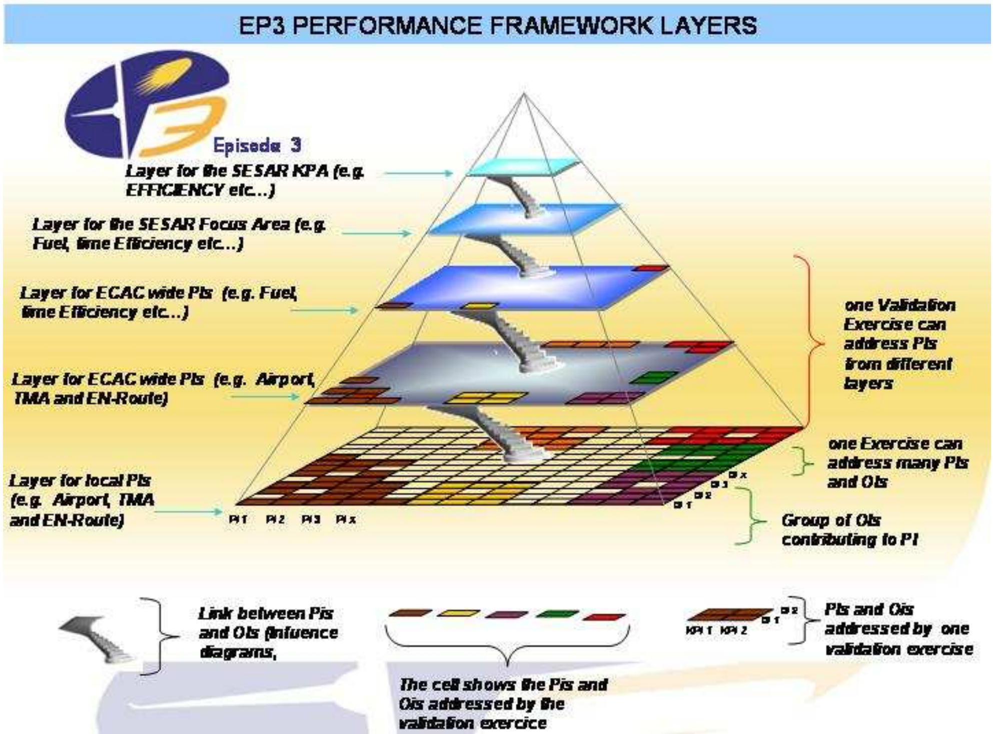

Figure 2-1. Performance Indicators Layers in the Performance Framework

The figure above shows the different layers of the Performance Framework that are derived from the performance Objectives and Targets described in SESAR D2 [9]. The three upper layers of the framework targets use the SESAR defined targets where available, further targets are being defined to improve the coverage. The targets for the 4th layer "Airport, TMA, En-route ECAC PIs" and 5th layer "Local PIs" will be derived applying the method that will be explained inside the section 5 Catalogue of Performance indicators.

The **Key Performance Area layer** represents the KPA that provides a way to categorise performances related to high level ambitions and expectations. ICAO has defined these ambitions as 11 KPAs: Safety, Security, Environmental impact, Cost Effectiveness, Capacity, Flight Efficiency, Flexibility, Predictability, Access and Equity, Participation and Collaboration Interoperability.

The Focus Area layer identifies within each KPA the Focus Areas with intentions to establish performance management. Focus Areas are typically needed where performance issues have been identified. For example, within the Capacity KPA one can identify airport capacity, airspace capacity and network capacity as Focus Areas. Within the Safety KPA the Focus Area ATM-related safety outcome is included.

The ECAC wide Performance Indicator layer addresses the ECAC wide picture of the performance. For example this can be the ECAC -i.e. Airport + TMA + En-route fuel consumption, CO2 emission or delays.

The Airport, TMA, En-route ECAC layers are a sub part of the ECAC wide Performance Indicator. They address the ECAC wide performance of all Airports, TMA, En-route of an OI or a group of OIs. For example this can be the influence of group of OIs on the fuel consumption for all the ECAC airports.

The Local PIs layer for Airport, TMA, En-route represents a sub part of the Airport, TMA, En-route or Network ECAC Performance Indicator to a local indicator. This addresses the local performance of an OI or a group of OIs. This can be the influence of group of OIs on the fuel consumption for a specific airport -e.g. Heathrow, Paris Charles de Gaulle assessed by the validation exercise for example but then it will be needed to develop a methodology to extrapolate such result in order to obtain a value at ECAC level.

The catalogue of Performance Indicators will be a library providing the description and a prioritisation list of the more useful indicators identified in each area. This catalogue will ensure consistency between the units and measurements employed by the validation exercises.

In the figure each cell shows the PIs and OIs addressed by a validation exercise (see Figure 2-2).

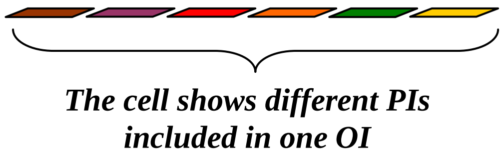

Figure 2-2. Exercises addressed

EP3 validation has been divided into several exercises. The exercises will clarify the Target Concept and some perform measurement in different layers -e.g. EP3 WP3, *Collaborative Planning Processes,* exercises may address PIs from several layers, Airport, TMA, En-route ECAC PIs but also at ECAC PIs level. Not all the OIs are contributing to the performance measured in the validation exercises, this is why one validation exercise may measure a subset of OI Steps (see Figure 2-3). All validation exercises imply the measurement of parameters, which can be subject to uncertainty -e.g. inaccuracy, noise. The amount of uncertainty will have to be determined by the validation exercises and processed within the Performance Framework.

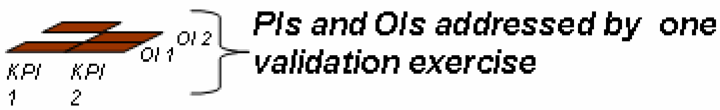

Figure 2-3. Validation exercises PI and OI addressed

There is a link represented by the stairs between the layers *-e.g. the overall consumption of fuel at ECAC level is the result of the sum of the fuel consumption in the Local PI for Airport, TMA and En-route* (see Figure 2-4). Not all the OIs will be addressed by the exercise, some of these gaps will be filled by expert judgment, including data from previous projects and SESAR.

Figure 2-4. Link between PIs and OIs (see Influence Diagrams, ECAC Model)

The influence diagrams, the methodology and the model is developed by the EP3 WP2.4.1, *Performance Framework,* and used to better qualify, quantify and understand the relationship between OIs, PIs and the layers.

The definition and targets values of the parameters defined in each layer will be described in detail.

2.1 Key Performance Areas and their Targets

Key Performance Areas and targets from SESAR D2 [9] to be addressed in EP3 are the political KPAs: Capacity, Environment, Safety and the Quality of Service KPAs: Efficiency, Predictability and Flexibility.

Environment and Safety will be the subject of focused studies. The safety assessment will be developed in WP2.4.3, *Safety Assessment*, and the Environmental Assessment will be developed in EP3 WP2.4.4., *Environmental Assessment*. The KPA definitions and targets established below take into account D2 of SESAR, *Air Transport Framework – the Performance Target* and the revised SESAR Performance objectives and Targets document. SESAR has defined Performance Targets at the ECAC level. Where possible, EP3 has identified targets at the lower level in terms of Performance Indicator.

2.1.1 Capacity

This KPA addresses the ability of the ATM System to cope with air traffic demand (in number and distribution through time and space).

In accordance with the political vision and goal, the ATM target concept should enable a 3-fold increase in capacity which will also reduce delays, both on the ground and in the air (en-route and airport network) to be able to handle traffic growth well beyond 2020.

The deployment of the ATM target concept should be progressive, so that only the required capacity is deployed at any time.

2.1.2 Environmental Sustainability

This KPA addresses the ability of the ATM System to be environmentally efficient by being able to limit its environmental impact.

The defined target for the future System is a reduction by 10% per flight of its environmental impact (ECAC-wide annual average).

Environmental impact, e.g. climate change, is difficult to quantify.

Generally, environmental assessment of aviation is mainly linked to the following three areas:

- Global aviation emissions (acting on climate change etc.);
- Noise; and
- Local Air Quality.

The EP3 environmental assessment assumes that the goal of 10% impact reduction is achieved if the assessment can indicate that the implementation of the new ATM system will lead to a reduction of 10% of the values of the relevant performance indicators, e.g. dB, kg of CO_2 etc., for above listed three areas.

2.1.3 Safety

This KPA addresses the risk, prevention, occurrence and mitigation of air traffic accidents.

The SESAR initial safety performance objective builds on the ATM2000+ Strategy [25] objective: "To improve safety levels by ensuring that the numbers of ATM induced accidents and serious or risk bearing incidents (includes those with direct and indirect ATM contribution) do not increase and, where possible, decrease".

Considering the anticipated increase in the European annual traffic volume, the implication of the initial safety performance objective is that the overall safety level would gradually have to improve, so as to reach an improvement factor 3 in order to meet the safety objective in 2020. This is based on the assumption that safety needs to improve with the square of traffic volume increase, in order to maintain a constant accident rate [9].

2.1.4 Efficiency

This KPA addresses the actual flown 4D trajectories in relation to their Shared Business Trajectory.

The initial Efficiency design target is an improvement in ATM efficiency split among the defined Focus Areas.

2.1.5 Predictability

This KPA addresses the ability of the ATM System to ensure a reliable and consistent level of 4D trajectory performance. In other words: across many flights, the ability to control the variability of the deviation between the actual flown 4D trajectories of aircraft in relation to the Reference Business Trajectory.

The initial Predictability design target is an improvement in ATM predictability focused on On-time operation (on-time means within 3 minutes[4] before or after the time reference), Service disruption effect and knock-on effects.

2.1.6 Flexibility

This KPA addresses the ability of the ATM System and airports to respond to “sudden” changes in demand and capacity: rapid changes in traffic patterns, last minute notifications or cancellations of flights, changes to the Reference Business Trajectory “–i.e. pre-departure changes as well as in-flight changes, with or without diversion”, late aircraft substitutions, sudden airport capacity changes, late airspace segregation requests, weather, crisis situations.

As well as to indicators identified within Focus Areas, there are two additional indicators to be included with no target identified. These are required to design the system with appropriate trade-offs:

- Flexibility demand: this is the percentage of flights requesting, depending on the flexibility case:
  - Either a time translation of the Coordinated SBT, CSBT, or RBT;
  - Or a full redefinition of the CSBT or RBT.
- Lead time of the demand: this is the time difference between the time of the request and the next (possibly the first) flight event impacted in the CSBT or RBT.

[4] SESAR D2 §3.4.5.2, P84/149

2.2 FOCUS AREAS

2.2.1 Capacity Focus Areas

2.2.1.1 Airspace capacity

This Focus Area covers the capacity of any individual or aggregated airspace volume within the European airspace. It relates to the throughput of that volume per unit of time, for a given safety level.

The initial indicative design target for Capacity deployment is that the ATM System can accommodate by 2020 a 73% increase in traffic (annual IFR traffic growth in the European network from 2005 baseline) while meeting the targets for quality of service KPAs (Efficiency, Flexibility, Predictability): 5% per annum in the period 2005-2010, 3.5-4% per annum during 2010-2015, 2-3% per annum during 2015-2020, and 2% per annum beyond 2020. This corresponds to an optimistic demand forecast combined with an optimistic airport capacity growth scenario, which assumes that there will be very few Greenfield airport development projects in Europe in the next 20 years.

2.2.1.2 Airport capacity

Focus is on the throughput of individual airports in terms of aircraft movements, taking into account the composite effect of air- and landside constraints. So this Focus Area covers much more than just runway capacity. Focus is also on the throughput of individual congested airports in low visibility (i.e. IMC) conditions.

For airports with no special physical constraints (including environmental considerations) the objectives are:

- Increase hourly capacity in nominal conditions;
- Decrease the capacity gap between VMC and IMC conditions.

Airport daily capacity targets expressed previously by daily movements are replaced by hourly capacity targets. This hourly capacity is "the best in class"[5] value available 365 days per year, from 0700 till 2200 hrs local time:

- 60 movements per hour , mvts/hr, in VMC (and 48 mvts/hr in IMC) for airport with a single runway;
- 90 mvts/hr in VMC (and 72 mvts/hr in IMC) for airport with parallel but dependent runways;
- 120 mvts/hr in VMC (and 96 mvts/hr in IMC) for airport with parallel and independent runways.

Congested airports will need a capability for sustained operations at maximum capacity during most hours of the day. Avoiding disruptions is top priority for those airports.

These targets are **declared capacity** targets for the Best in Class (BIC) airport in each category. This means that the airport schedule is based on these values. The “single runway BIC” handles 60 mvts/hr in VMC conditions and 48 mvts/hr in IMC conditions in the busy hours. However, individual airports can have local restrictions that prevent them from reaching the BIC performance.

[5] SESAR Definition Phase Task 2.3.1 - Milestone 3 DLT-0612-231-00-09 §6.3.3.1 P123/161 and revision SESAR Definition report Performance Objectives and Targets RPT-0708-001-01-02 §3.2.2 P14/84

2.2.1.3 Network capacity

This is concerned with overall network throughput, taking into account the network effect of the airspace and airport capacity in function of traffic demand patterns.

The deployment requirement means that the annual number of flights to be handled by the ATM System will increase from 9.1 to approximately 16 Mn flights p.a. within the 2005-2020 period. During the busiest months of the year, the system should be able to handle 50,000 flights/day around the year 2022[6].

These are the average European design targets (at network level). When transposing this to local targets, regional differences will exist. The ATM target concept should be able to support a tripling or more of traffic where required.

2.2.2 Environment Focus Areas

The EP3 environmental assessment framework will align with the overall EP3 Performance assessment framework. It will apply this approach and layered model to three out of the five different environmental Focus Areas identified by SESAR D2 [9]; SESAR D2 Initial Focus Areas are:

- FA-13 Environmental constraint management;
- FA-14 Best ATM Practice in Environmental Management;
- FA-15 Compliance with environmental rules;
- FA-16 Atmospheric Impacts;
- FA-17 Noise Impacts.

The two areas out of the scope of EP3 are Compliance with environmental rules, and Best ATM Practice in Environmental Management.

Compliance with environmental rules (SESAR FA-15) requires that those rules are defined and known for the present and as well for the future, e.g. 2020. The environmental rule set which will apply for the future covered by SESAR and EP3 is not known. For that reason SESAR FA-15 is not investigated with in the EP3 environmental assessment.

SESAR FA-14 Best ATM Practice in Environmental Management is understood to be covered by the European Commission project CAATSII [1]. EP3 intends to avoid multiplication of efforts for same or similar deliverables will not address that SESAR FA-14 for above mentioned reason.

While the understanding of aircraft emissions is well understood and its measurement and modelling well developed, this is not the case for the environmental impact of these emissions (SESAR FA-16). The scientific complexity of atmospheric research and the enormous error levels, e.g. contrails, contrail cirrus, with regards to climate change consequences of aviation emissions do not seriously allow a scientific assessment within EP3.

Given the current difficulty in providing atmospheric impact, EP3 instead will assess Global Emissions and Local Air Quality.

EP3 defines the following Focus Areas for analysis:

- Global Emissions (Green House Gas emissions (GHG), Global Warming, Climate Impact etc.);
- Noise (dB, exposed population);

[6] SESAR D2 §3.4.2.2 P79/149

- Local Air Quality (Particulate Matter (PM), Hydrocarbons (HC), Volatile Organic Compounds (VOC), Ozone, etc.);
- Meteorology (not a performance area).

Each of the first three Focus Areas aims to provide environmental performance information for the three layers mentioned above; e.g. ECAC wide; Airport, TMA, En-route, network and Local. The activity with regards to Meteorology is limited to a screening and scoping of the proposed concept, to identify the Target Concept elements with relevance to this subject area. It will not provide performance figures.

2.2.2.1 Global Emissions

Global Emissions measures the complete set of emissions produced by only the aircraft along its complete mission execution. This is done on a flight by flight base. A typical application is for example the assessment of the emissions produced at one day by all movements over Europe. The periods of the flight operated below 3000ft are either ignored or can be assessed in a simplified form by using the ICAO Landing and Take Off (LTO) cycle model, since global emission traffic scenarios usually do not provide sufficient detail information to assess the part of the flight with sufficient precision. The EP3 project will include the ICAO standard Landing and Take Off cycle emissions for flight phases below 3000ft during the global emission assessment.

This simplification can be redressed where necessary in the EP3 project by an additional Local Air Quality assessment to increase the precision of the emission information for those parts of the flight.

2.2.2.2 Local Air Quality

Local Air Quality assessments usually include the aircraft emissions from its Landing and Take Off cycle, Auxiliary Power Unit emissions, engine testing, passenger surface access to airports, fuel storage, background concentrations, emissions of ground vehicles and equipment and buildings etc.

EP3 Local Air Quality assessments include all emissions below 3000ft. This ceiling is derived from the ICAO LTO cycle. The ICAO LTO cycle is theoretical definition of the aircraft operation below 3000ft (approach, landing, runway, taxi-in, taxi-out, taxi-off, and climb-out).

2.2.2.3 Noise

EP3 will use the standard methodology for noise assessment, which is the production of noise maps around airports according to specific noise metrics. These metrics address noise impact of airport inbound and outbound movements, either at a single-event level or for a complete traffic sample. Noise assessment covers the aircraft contribution only, excluding any other sources such as ground vehicles etc.

If geo-referenced population data is available, the number of people exposed to significant noise levels (counting of number of people living inside specific contour bands) can then be estimated.

2.2.3 Safety Focus Areas

This section first states the Safety targets as it appears in the SESAR documents and then attempts to define the metrics in which the target is measured, the scope of activities to which the target refers, i.e. as a whole define what is meant by the ATM contribution to safety and risks. It does not present the approach towards assessing the safety of the SESAR concept of operations, this approach can be find in White Paper on the SESAR Safety Target [24].

SESAR has defined in safety only one Focus Area, the Focus Area ATM-related safety outcome.

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Safety criteria define acceptable level of safety. To use a safety level as a target, it is necessary to define the units of measurement; in other words, the risk metric that is used. Because safety is a complex multi-dimensional subject, it is possible for different metrics to show different behaviour. For example, they may change at different rates, and in some cases one metric may increase while others decrease.

The ATM2000+ Strategy, which underlies the SESAR target, uses a clear metric of "*the numbers of ATM induced accidents and serious or risk bearing incidents*". This is interpreted as meaning the annual number of such events.

The SESAR target does not state the metric to which it refers. However, the derivation includes an explicit assumption that "*safety needs to improve with the square of traffic volume increase, in order to maintain a constant accident rate*" [9]. This makes clear that its metric is related to the square of the number of flights. Such metrics are commonly used in collision modelling, where the risk is assumed to depend on the number of "encounters" between two aircraft. An encounter is when the planned trajectories of two aircraft come within a defined distance of each other. A specific type of encounter is a "conflict", where planned trajectories would result in separation infringement in the absence of any interference by ATM.

For example, if the annual number of accidents is to be kept constant while the annual traffic increases by a factor of 3, the accident probability per encounter must reduce by a factor of 9. In the SESAR target, this is rounded to 10. Similarly, if the annual traffic increases by 73%, the accident probability per encounter must reduce by a factor of $1.73^2 = 3$. This is sufficient to explain the numbers in the target.

The SESAR target is therefore seen to be based on the ATM2000+ metric of the annual number of accidents, but the quoted 10-fold safety improvement refers to the metric of accidents per encounter, or an equivalent that varies with the square of the traffic, as it is common to count each aircraft involved in a collision separately. This is only meaningful for collisions between two aircraft, and therefore the original ATM2000+ metric is more useful for single-aircraft accidents. The rationale behind is explained in White Paper on the SESAR Safety Target [24].

EP3 will use both metrics, the ATM2000+ metric for the general safety assessment, and the accidents per encounter when assessing the compliance of SESAR with the 10-fold target.

In this document 'ATM-induced' means both:

- ATM failing to prevent an accident or incident to happen or causing an accident or incident that would otherwise not have occurred within the normal scope of ATM;
- The effectiveness of ATM in preventing aviation accidents and incidents that would normally be considered to be out of scope. To make this point clear, ATM is likely to be a cause in mid-air collisions, but less likely to be so in Controlled Flight Into Terrain (CFIT) accidents. However, ATM could possibly help considerably in preventing CFIT accidents, which are far more likely than mid-air collisions.

The scope of this target is therefore defined as follows:

- Accidents - as defined by ICAO Annex 13 [2] and ESARR 4 [6];
- Involvements - in the case of collisions, each aircraft involved is counted separately;
- Accident, incident and safety occurrence types - any type of event (excluding unlawful related events) with an ATM contribution (direct and indirect);
- Contribution - any event that causes the failure of a barrier that normally serves to prevent the accident, or which represents the benefits of ATM in preventing accidents and incidents;
- ATM contribution - a contribution to an accident from any person or system (whether ground-based, space-based or airborne) performing an ATM function, or the positive contribution of ATM in preventing aviation accidents and incidents;

- It applies to Air Navigation Services (ANS), which rely on the ATM functional system, including CNS, ASM and ATFCM functions. It also applies to the safety levels of AIS and MET data used by these elements;
- Geographical extent - all of the ECAC region;
- Airspace - all types of airspace (whether intended or unknown traffic environments);
- Traffic - all types of aircraft with Maximum Take-Off Weight, MTOW > 2.25 tonnes, operating under IFR (however, the consequences of the occurrence of potential hazards related to lighter aircraft on the safety of SESAR operations will be assessed);
- Flight phases - the whole gate-to-gate cycle is included;
- Time period - from 2005 to SESAR implementation end-state (2020 and beyond).

In conclusion, the safety target to be used by EP3 will be achieved provided there is no increase in the expected annual frequency of ATM contributions to ICAO-defined accident involvements of all IFR traffic with MTOW over 2.25 tonnes. This is in all gate-to-gate phases, in all airspace types and over the whole ECAC region between 2005 and SESAR implementation end-state, notwithstanding any increase in air traffic over that period.

2.2.4 Efficiency Focus Areas[7]

2.2.4.1 Temporal efficiency

This Focus Area covers the magnitude and causes of deviations from planned (on-time) departure time and deviations from Initial Shared Business Trajectory durations (taxi time, airborne time).

The Estimated Off Block Time (EOBT) as defined in the CSBT is used as the reference when determining whether a flight is “on-time” or not. If the actual off-block time (AOBT) occurs within the period 3 minutes before or after the reference EOBT the flight will be considered as “on-time”. If the AOBT occurs more than 3 minutes after the reference EOBT the flight will be considered as having a delayed departure:

- Occurrence (Punctuality): at least 98% of flights departing on-time;
- Severity (Delays): the average departure delay of delayed flights will not exceed 10 minutes.

Flight duration efficiency understanding by normal flight duration what is defined as actual block-to-block time less than 3 minutes longer than the block-to-block time of the Initial Shared Business Trajectory and by extended flight duration what is defined as actual block-to-block time more than 3 minutes longer than the block-to-block time of the Shared Business Trajectory:

- Occurrence: more than 95% of flights with normal flight duration;
- Severity: the average flight duration extension of flights will not exceed 10 minutes.

2.2.4.2 Fuel efficiency

This Focus Area covers the magnitude and causes of deviations from optimum fuel consumption.

The envisaged target for Gate to Gate fuel efficiency (Actual compared to Initial Shared Business Trajectory) will be addressed by:

[7] All targets in this section are extracted from SESAR D2 §3.4.3.2, P80-81/149.

- Occurrence: less than 5% of flights suffering additional fuel consumption of more than 2.5%;
- Severity: for flights suffering additional fuel consumption of more than 2.5%, the average additional fuel consumption will not exceed 5%.

2.2.4.3 *Mission Effectiveness*

The mission effectiveness focus area concentrates on the impact of transit time to/from the designated operating area on the mission cost and time.

2.2.5 Predictability Focus Areas[8]

2.2.5.1 *On-Time operation*

This Focus Area covers the variability of the flight operation: departure (off-block) and arrival (on-block) punctuality, and the variability of flight phase durations (turnaround time, taxi time, airborne time):

- Arrival punctuality: less than 5% (ECAC-wide annual average) of flights suffering arrival delay of more than 3 minutes;
- Arrival delay: the average delay (ECAC-wide annual average) of delayed flights (with a delay penalty of more than 3 minutes) will be less than 10 minutes;
- Variability of flight duration (off-block to on-block): coefficient of variation[9] is 0.015.

2.2.5.2 *Service Disruption Effect*[10]

The focus here is on the prevention and mitigation of the Business Trajectory effects of ATM service disruption. Such effects can take the form of departure/arrival delays, flight cancellations and diversions.

The performance targets for 2020 based on the 2010 baseline are:

- Reduction of cancellation rates by 50%;
- Reduction of diversion rates by 50%;
- Reduction of total disruption delay by 50% (ECAC wide annual average).

2.2.5.3 *Knock-on effect*

The focus here is on the (lack of) impact On-Time operation and schedule buffers on subsequent flights. Such impact takes the form of reactionary delays, and in more extreme cases may lead to flight cancellations.

The performance targets for 2020 based on the 2010 baseline are:

- Reduction of reactionary delay by 50%;

[8] All targets in this section are extracted from SESAR D2 §3.4.5.2, P84/149.

[9] A coefficient of variation is equal to the standard deviation divided by the mean value.

[10] The disrupted conditions are an abnormal operational capability as a result of technological failure (e.g. radar failure), abnormal WX (e.g. icing, excessive RWY crosswind) or service disruption (e.g. security threat or industrial action) that could leads to cancellation, diversion or even delay an individual flight. Let's say that in 2010 out of every 100 planned flights 2 are cancelled due to "disrupted conditions", then the target is that in 2020 out of every 100 flights only 1 is cancelled due to "disrupted conditions" (cancellation rate from 2% to 1%, which is a reduction of 50%).

- Reduction of cancellation rate (cause by ATC) by 50% (ECAC-wide annual average).

2.2.6 Flexibility Focus Areas[11]

2.2.6.1 Business Trajectory update flexibility for scheduled and non scheduled flights

This Focus Area covers the ability of the ATM System and airports to accommodate airspace user requests for Coordinated Shared Business Trajectory (CSBT) or Reference Business Trajectory (RBT) updates of scheduled and non-scheduled flights, ranging from simple time translation (depart/arrive earlier/later) to full RBT redefinition "-i.e. changes to aircraft, route, vertical profile, destination".

The initial indicative design targets are:

- Of the scheduled flights requesting a change in departure time, no more than 2% (ECAC-wide annual average) will suffer a delay penalty of more than 3 minutes (with respect to their requested time) as a consequence of the request;
- The average delay (ECAC-wide annual average) of such scheduled flights (with a delay penalty of more than 3 minutes) will be less than 5 minutes;
- At least 95% (ECAC-wide annual average) of the (valid) requests for full Reference Business Trajectory (RBT) redefinition of scheduled and non-scheduled flights will be accommodated, albeit possibly with a time penalty (i.e., departure and/or arrival delay);
- Of the scheduled and non-scheduled flights with a successfully accommodated request for full RBT redefinition, no more than 10% of the flights (ECAC-wide annual average) will suffer a delay penalty (i.e., departure and/or arrival delay) of more than 3 minutes (with respect to their requested time) as a consequence of the request;
- The average delay of such scheduled and non-scheduled flights with a successfully accommodated request for full RBT redefinition (with a delay penalty of more than 3 minutes) will be less than 5 minutes.

Please note that to be fully defined, these targets need a timeframe reference on when requested changes/non-scheduled flights are received.

2.2.6.2 Flexible access-on-demand for non-scheduled flights

This Focus Area covers the ability of the ATM System and airports to accommodate non-scheduled flights.

At least 98% (ECAC-wide annual average) of the non-scheduled flight departures will be accommodated with a delay penalty less than 3 minutes.

The average delay (ECAC-wide annual average) of such non-scheduled flight departures (with a delay penalty of more than 3 minutes) will be less than 5 minutes.

2.2.6.3 Service location flexibility

Focus is on the ability of the ATM System to make services available at (relatively) short notice in airspace and at airports where previously no service was available.

At least 98% (ECAC-wide annual average) of the VFR-IFR change requests will be accommodated without a delay penalty of more than 3 minutes.

[11] All targets in this section are extracted from SESAR D2 §3.4.4.2, P82-83/149.

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Please note that to be fully defined, this target needs a timeframe reference on when short notice changes request are received.

2.2.6.4 Suitability for military requirements

Focus is to reflect the suitability of the ATM System for military requirements related to the flexibility in the use of airspace and reaction to short-notice changes.

3 INFLUENCE DIAGRAMS

Before describing the Performance Framework methodology, this chapter describes the Influence Diagram developed within the framework of Episode 3.

3.1 BACKGROUND

"Influence analysis" has been introduced as a decision support tool, offering an intuitive graphical notation that supports effective communication. The graphical notation is called "influence diagram", while the full specification constitutes the "influence model".

As described by Kjaerulff and Madsen [7], an influence model can be defined as a **probabilistic network** for reasoning about **decision making** under uncertainty. It is both a graphical and mathematical representation of a decision problem involving a sequence of interleaved decisions and observations:

- The graphical representation offers an intuitive way to identify and display essential decision elements. It reduces the apparent complexity of a problem;
- The mathematical representation enables uncertainties and objectives to be assessed.

The influence diagrams developed in SESAR WP2.3.1 are used as a starting point to build the relationships among the different layers of Performance Indicators and Key Performance Areas. The EP3 improvement to the SESAR influence diagrams work includes a wider coverage of the KPA and the use of a decision support tool that ensures consistency between the influence diagrams and the model and allows diagrams to be presented at different levels of detail. The EP3 Influence Diagram is given in Annex II.

Figure 3-1 gives a simplified example of a part of the influence diagram illustrating the variety of aspects that may influence one single Performance Indicator.

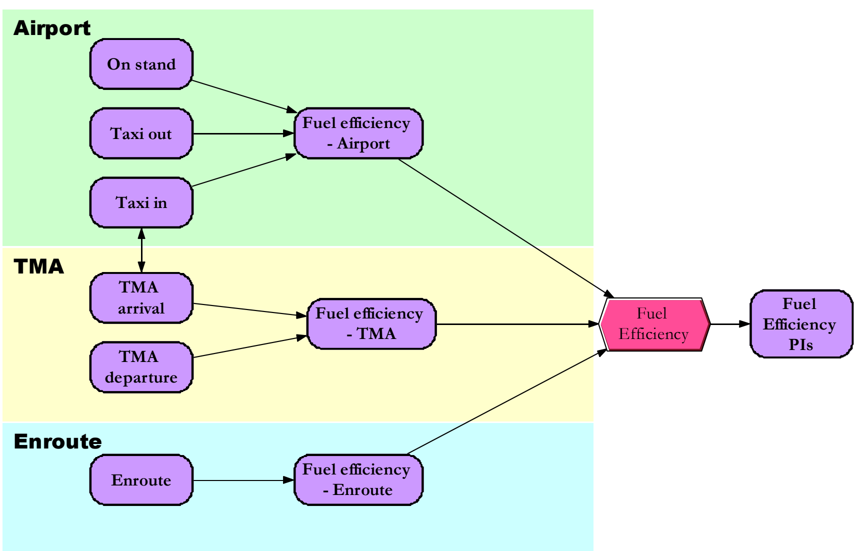

Figure 3-1. Example of influence diagram

3.2 ANALYSIS OF THE INFLUENCE DIAGRAMS PROVIDED BY SESAR D3 AND D4

SESAR WP2.3.1 provided two different sets of influence diagrams for SESAR D3 [17] and SESAR D4 [15], which were both used as input for the EP3 Influence Diagram. EP3 Influence diagrams focuses on six KPAs: Capacity, Efficiency, Flexibility, Predictability, Environment and Safety. The KPA Cost-Effectiveness is currently not addressed but it might be included depending on the evolution of the inputs available in the project. Table 3-1 below lists the coverage of KPAs and Focus Areas by SESAR D3 and D4 in terms of influence diagram (ID) or influence model (IM).

EP3 KPAs	EP3 Focus Areas	D3	D4	EP3 WP2.4.1
Capacity	Airspace Capacity	ID	ID+IM	ID+IM
	Airport Capacity	ID	ID+IM	ID+IM
	Network Capacity	ID	ID	ID
Efficiency	Temporal-Efficiency	ID	ID	ID+IM
	Fuel-Efficiency	ID	ID+IM	ID+IM
	Mission-Effectiveness			ID
Flexibility	BT update for scheduled and non scheduled flights	ID	ID	ID
	Flexible access-on-demand for non-scheduled flights	ID	ID	ID
	Service Location Flexibility		ID	ID
	Suitability for military requirements			ID
Predictability	On-time Operation	ID		ID
	Service Disruption Effect	ID	ID	ID
	Knock-on Effect	ID	ID	ID+IM
Environment	Global emissions			ID + part quantified IM
	Noise			ID
	Local air quality			ID
Safety	ATM-related safety outcome			ID

Table 3-1 KPAs and Focus Areas together with the availability or not of an ID IM coming from SESAR

3.2.1 SESAR D3 Influence Diagrams

The diagrams developed in SESAR D3 [17] are primarily aimed at gathering expert knowledge and at describing as precisely as possible the decision processes and the data flows relating to operational KPAs. The aim was ambitious considering the short time frame to develop the diagrams. Several experts were involved in the production of the diagrams, and although some efforts were made to simplify the real mechanisms, it resulted in 27 diagrams, that included:

- 10 diagrams with a KPA and Focus Area perspective (i.e. 3 diagrams on Capacity, 3 diagrams on Efficiency, 2 diagrams on Flexibility and 2 diagrams on Predictability);

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- 12 diagrams with a functional perspective (i.e. 3 diagrams on “Demand Capacity Balancing”, 6 diagrams on “Air Traffic Control”, 3 diagrams on “Airspace Organisation and Management”); and
- 5 diagrams with an airport perspective (i.e. Airport efficiency, Arrival ATM delays, Airport predictability, Airport capacity and Airport flexibility).

The D3 diagrams comprise a total of 206 variables and 62 mechanisms. The experts, who had to work on the diagrams for the purposes of SESAR D3 [17] and D4 [15] activities, reported that the D3 diagrams appeared to be too detailed to communicate at a high-level on how different operational concepts may affect future performance. It was then decided to produce more abstract diagrams, with the constraint to cap the maximum size of a diagram to one page per KPA in D4 [15].

3.2.2 SESAR D4 Influence Diagrams

This section focuses on the work done in the context of D4 [15] (qualitative and some quantitative assessments) and, therefore, there are some differences with respect to the work done in the context of D3 [17] in terms of notations.

Influences models in D4 used models map from the main operational characteristics and influencing factors to performance outputs. They used the information gathered from the Initial Assessment carried out for D3 that attempted to quantify the likely impact of OCEs on the main factors, aggregating them to a realistic overall KPA expectation.

The purpose of the work done by SESAR T231 in the context of D4 was to provide performance assessments of benefits expected from SESAR Implementation Packages, mostly the IP2 medium term package (2013-2020).

Performance categories defined in SESAR D4 were: Airspace Capacity, Airport Capacity, Predictability, Fuel Efficiency, Time Efficiency, Flexibility, Disrupted service and Cost Effectiveness, some are the focus areas (Airspace Capacity, Airport Capacity, Fuel efficiency, Time efficiency) some are directly related to the KPAs (Predictability, Cost Effectiveness, and Flexibility). SESAR D4 realised that the low visibility occurrence at airports had direct influence on, at least, Capacity and Predictability KPAs, so Disrupted service was also developed through an Influence Diagram.

The assessments performed were nearly all judgement based. Most assessments were performed at a qualitative level; however for a few performance categories (Airspace Capacity, airport Capacity, Fuel Efficiency) it was deemed both feasible and necessary to perform quantitative assessments as well.

In order to describe the effect of the known IP2 Operational Improvement Steps on the targeted performance areas, it was necessary to propose a description of the elementary improvement factors influencing the performance and of the relationship between these factors. These descriptions, the ID[12], have been developed for each performance category to be assessed (most of these categories directly map SESAR performance areas).

Each Influence Diagram is built for a given performance category and is meant to help during the assessment of the performance contribution that the Target Concept can deliver in 2020.

The Influence Diagrams help by breaking down overall performance into “factors”, i.e. aspects or sources of performance, thus making it easier to think about the impact that Concept changes might have and justify and communicate performance expectations and claims.

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[12] Descriptions based on Influence Diagrams were used previously by SESAR Task 2.3.1, for the purpose of providing trade-off assessments between Key Performance Areas; these assessments were presented in SESAR Deliverable 3. At the time, the Concept of Operations (ConOps) was structured in terms of Operational Concept Elements and those assessments were conducted with that structure in mind.

The quantitative assessment consisted of retrieving suitable baselines performance figures, completing them by judgement where necessary, and of assessing relative performance improvement figures to each performance factor, bearing in mind the associated Operational Improvements.

It is assumed that baseline performance contributions from the main factors can be estimated. This requires the assessor(s) to have a good baseline performance understanding of the contribution to current performance of the respective factors, or at least a good understanding of the scope for improvement of each factor. As such, the assessment must be carried out collectively across the OI Steps relevant to a performance factor in a particular timeframe (or Implementation Package).

It is fair to expect the quantitative assessments derived from Influence Diagrams to deliver “order of magnitude” results.

Influence Diagrams were produced for the following performance categories: Airspace Capacity, Airport Capacity, Predictability, Fuel Efficiency, Time Efficiency, Flexibility, Disrupted Service and Cost Effectiveness.

The assessments were performed as follows:

- Influence Diagrams definition;
- Mapping of Operational Improvement Steps to improvement factors;
- Qualitative assessments;
- Quantitative assessments.

The purpose of the Influence Diagrams is to provide descriptions of the elementary improvement factors influencing the performance benefits and of the relationship between these factors; they are detailed in graphical format in the following sections.

For each performance category, each Operational Improvement (OI) step was tentatively assigned to an improvement factor. Whenever an effect of step on factor was found, the OI step was retained. This led to the constitutions of clusters of OI steps for each factor. There remains the possibility that for a given factor no OI step has any effect on this factor, in which case said factor does not influence the performance category where it belongs. This first allocation was done by SESAR D4 members. EP3 PF has refined the OI allocation.

Then for each OI step cluster, a qualitative assessment was made. The following levels of effect were considered: Low, Medium and High. For the ‘no effect’ case the assessment remained silent. Whenever a potential negative effect was detected, it was also recorded. A limited number of quantitative assessments were then made.

Experts involved in the SESAR activities reported that the level of detail adopted in the D4 [15] diagrams was found appropriate for supporting communication to an audience as wide as SESAR’s. However, there is an obvious trade-off between the communication requirements (leading to highly simplified diagrams) and the level of detail required to gain confidence in the quantitative results of the models.

4 PERFORMANCE FRAMEWORK METHODOLOGY

This chapter describes a methodology for creating an ECAC Model of performance using outputs from EP3 Validation Exercises. This ECAC Model will aggregate local performance results to enable a future overall assessment of the new ATM concepts defined in SESAR.

The previous sections have analysed, developed and classified the information about indicators coming from SESAR. This section will define a methodology to create the ECAC Model establishing the links between the different layers identified.

The information provided by the SESAR D1 [16] and D2 [9] has set the initial state needed to build the ECAC Model. In section 4.1, the methodology to create the ECAC Model will be introduced. Eventually, this methodology has resulted in the EP3 Influence Model, consisting of the model itself (developed using Analytica Professional, version 4.1), an excel file with input data to the model and a User Manual. All documents / files are added as Annex to this report (see Annex II. Influence Diagram).

Outputs from the exercises, past studies and expert judgment fed the ECAC Model. These outputs were collected from:

- Simulation exercises results;
- Expert Groups;
- Modelling;
- Gaming;
- Past projects.

The model is developed on the basis of Influence Diagrams together with the PIs from the Catalogue of Performance Indicators provided in Section 5. Indicators outside this catalogue will need a post-processing exercise to adapt them to the established Performance Indicators.

In section 4.2 Integration of the EP3 validation exercises in the Performance Framework, the Performance Framework provides general guidelines to the validation exercises and WPs in order to develop their integration processes.

The management of the uncertainty inherent in the available data has been an important issue inside the methodology to develop the ECAC model. The correct handling of the uncertainty associated to the measurement will help to obtain a much more reliable performance assessment.

During 2008 and 2009 several tasks have contributed to the development of an initial ECAC Model. The influence diagrams take into account the management of the corresponding uncertainty. The guidelines for the integration process will have to explain how to integrate the values of the indicators obtained by the exercises but also the management of the corresponding uncertainty.

4.1 ECAC MODEL METHODOLOGY

EP3 will develop a set of validation activities to assess new ATM concepts developed in the SESAR project. SESAR project identified the key performance areas “e.g. Capacity, Efficiency” that are going to be improved by the new concepts. It is necessary to develop a system that links assessment activities with the KPAs to understand how KPAs are affected by the new concepts.

The Performance Framework provides the methodology to create a model to measure the performance, the ECAC Model, and also the instructions to use it. The performance assessment system will integrate some of the results, coming from the validation activities. The outcome of the ECAC Model provides a first assessment on some KPAs and PIs which will be comparable with the KPAs and PIs targets of the Performance Framework. The projections will be taken from the values obtained in the exercises execution, past studies, and expert judgment; these values will feed the ECAC model producing the projections on the KPAs and PIs. Notice that the KPAs and PIs targets are coming from SESAR and the work done by the WP2.4.1. see Section 2 and Section 5 Catalogue of Performance indicators for more information about KPAs and PIs targets.

The ECAC Model consists of an internal structure of links between different influence elements. Linked to some of these elements will appear the different layers of performance indicators defined in Section 2 and 5. These layers and the links between the influence elements will define the internal architecture of the assessment system. A good definition of the architecture is the key element to have a good performance assessment. The theory behind the internal architecture of the performance assessment system will be explained in the Section 4.1.3 *ECAC Model*.

The aim is that once the ECAC Model is fully developed, it will allow variations in the PI values to be traced through to the overall KPA performance level. Where a shortfall versus the defined KPA performance target is seen, it will be possible to identify the influence elements and PIs that are causing that effect. It is important to notice that the performance framework issued by WP2.4.1 will contain influence diagrams for Capacity, QoS (Flexibility, Efficiency and Predictability), Environment and Safety. WP2.4.1 developed an initial model to measure the performance related to Capacity, Efficiency and Environment.

The following steps are required to develop the ECAC Model:

- Create the layers of performance indicators needed by the ECAC Model. Once the main strategy has been established in the SESAR D2 [9], the KPAs and their targets, it must be detailed into manageable chunks that can be implemented and monitored. This is done in SESAR through the Focus Areas that divide the ATM system into its main subsystems. The Performance Framework has created more performance indicators layers below the Focus Areas. The new layers described in the Catalogue of Performance Indicators are the ECAC PIs, the Airport, TMA and En-route ECAC PIs, and the Local Performance Indicators; Influence diagrams will describe the processes and elements that lead to a change of the different KPA. PIs will be linked to those mechanisms.

- Define the integration map that connects different processes and elements through influence links. The integration map establishes the dependences between the strategic objectives, processes, the KPAs and PIs. The integration map thus shows the logic in how the Performance Framework will go about with the strategy to achieve the model of performance. The integration map will be composed by the influence diagrams that show the influence relationships.

  Influence diagrams have partially been done in SESAR D3 [17] deliverable and further developed in SESAR D4 [15]. In SESAR D3 [17] benefit mechanisms were identified and links between Key Performance Areas, main SESAR objectives, and concept elements were described. In SESAR D4 [15] new links were identified between KPA, Focus Areas, performance categories, and Operational Improvements. There is still a lot of work to be done by WP2.4.1 to get a complete influence diagram needed to build the ECAC Model. It will be necessary to determine a consistent traceability between the different layers of the internal architecture of the ECAC Model in order to develop a correct assessment system;

- Creation of the ECAC Model. Provide the relationship between the different elements of the influence diagrams to integrate the values of the performance indicators from one layer to the higher layer in order to obtain the performance assessment. Ideally this relationship will be clear equations or algorithms on which the ATM community agrees, other possible approaches could be provided for the integration process during the development of the model, like different type of simulations or modelling. All the assumptions will be tracked to understand the influences considered and enhance the buy in. An initial ECAC model will be developed in 2009 together with the User Manual and Calibration means.

Feeding the PIs with measures, and following the linkages, assessment about the KPA will be performed. Analysing this assessment, future strategies can be identified.

The objective of WP2.4.1 is to develop an initial ECAC Model with a calibration plan and a user manual. This initial model will highlight the areas where further development is needed to better identify its elements and links.

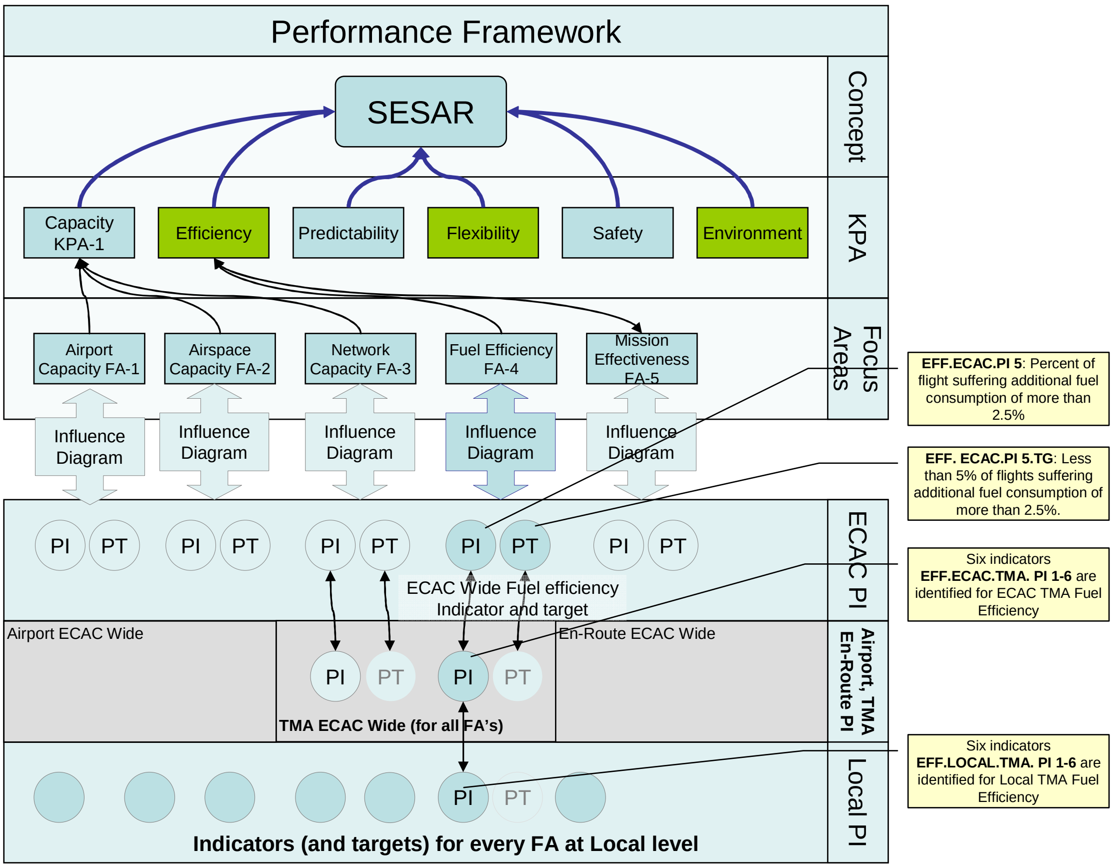

Figure 4-1. ECAC Model

4.1.1 Creation of the ECAC Model Layers

The definition of the ECAC Model layers will use as input the performance indicators layers defined in the section 2 EP3 Performance Framework Layers together with the layers coming from the Influence Diagrams developed within SESAR. The performance indicators will be linked to the mechanisms in the influence diagrams. The different layers in the performance framework and in the influence diagrams will help to perform this link as they state the scope of the elements within each layer. EP3 WP 2.4.1 does not foresee a direct an easy link between them, rather a first "general" assignment (in clusters) and afterwards a refinement case by case.

The initial ECAC Model will only use performance indicators related to the KPAs Capacity and Quality of Service (Efficiency, Flexibility and Predictability), Safety and Environment. The model is opened to the possibility of adding indicators related to the other KPAs in order to provide a wider performance assessment.

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As mentioned above, WP 2.4.1 is in charge of developing initial Influence Diagrams related to four KPAs, these are Capacity and QoS (Flexibility, Efficiency and Predictability), the KPAs Environment and Safety have their own related work packages, WP2.4.3, *Safety Assessment* and WP2.4.4., *Environmental Assessment*. It will be possible to integrate the results coming from the work done by those work packages into simplified Influence Diagrams.

The layers needed by the ECAC Model are:

- KPAs;
- Focus Areas;
- ECAC PIs;
- Airport, TMA, En-route ECAC PIs;
- Local Performance Indicators.

It will be possible to customize the layers, adding or removing performance indicators related to the KPAs that are going to be assessed.

4.1.2 Definition of the Integration Map

The integration map of the ECAC Model is the architecture of processes and elements that have an influence on performance within a given KPA. The integration map establishes the links between the influence elements defined in the different ECAC Model layers.

Each layer of the ECAC Model provides a different point of view about the performance assessment, from local to global, to ECAC wide, finalizing with the KPA level. The process that provides the method for integration of the values from one level into the higher level will be described section 4.2.

The validation exercises focus on some OI Steps in order to assess the Target Concepts included in the SESAR CONOPS [11]. A validation experimental plan of the exercise will have to provide to the ECAC Model:

- The OI Steps that the exercise is going to address;
- The performance indicators from the Catalogue of Performance Indicators that the exercise is going to produce as outputs. The ECAC model will only integrate the outputs given in this format;
- With the information provided by the Performance Framework and the validation exercises, it will be possible to find missed indicators.

The following sub-sections show the architecture in terms of links between the different layers of the ECAC Model. It is important to notice that the links between all the performance layers are not finished yet. The development of the influence diagrams during 2009 will fill in some of these links.

4.1.2.1 First Level. KPAs

The KPAs included in the architecture of the ECAC Model for which Influence Diagrams will be developed are Capacity, QoS - understanding QoS as Efficiency, Flexibility and Predictability – Safety and Environment. Variations in KPA values at this level of the ECAC Model will indicate the overall performance impact of the SESAR concept.

The KPA level of the ECAC Model can be expanded by the addition of new KPAs, like Environment and Safety whose performances are also important for the overall performance measurement. Although the ECAC Model can incorporate the traceability of the Environment and Safety KPAs, the only objective of the Performance Framework related to these KPAs is to establish initial Influence diagrams and facilitate the future extension of the ECAC Model.

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The table below shows the KPAs defined in SESAR D2 [9].

KPA ID	KPA Title
KPA-1	Capacity
KPA-2	Efficiency
KPA-3	Flexibility
KPA-4	Predictability
KPA-5	Environment
KPA-6	Safety

Table 4-1 KPAs defined in SESAR D2

4.1.2.2 Second Level. Focus Areas

The Focus Areas should be understood as a first detailed division of the KPAs, the division has been made in logical key areas that have the bigger effect in each KPA. The Focus Areas are defined in SESAR D2 [9].

The table below shows the Focus Areas defined in SESAR D2 within each of the KPAs. Below is the Focus Areas as defined in EP3 and its relationship with SESAR D2.

KPA ID	KPA Title	Traceability from FA ID	FA Title
KPA-1	Capacity	FA-1	Airspace Capacity
		FA-2	Airport Capacity
		FA-2	Network Capacity
KPA-2	Efficiency	FA-3	Temporal efficiency
		FA-4	Fuel efficiency
		FA-5	Mission Effectiveness
KPA-3	Flexibility	FA-6	Business Trajectory update for scheduled and non scheduled flights
		FA-7	Flexible access-on-demand for non-scheduled flights
		FA-8	Service location flexibility
		FA-9	Suitability for military requirements
KPA-4	Predictability	FA-10	On-Time operation
		FA-11	Service Disruption Effect
		FA-12	Knock-on effect
KPA-5	Environment	from FA-13	Local Air Quality
		from FA-16	Global Emissions
		FA-17	Noise Impacts
		-	Meteorology
KPA-6	Safety	FA-18	ATM-related safety outcome

Table 4-2 Focus Areas defined in SESAR D2 within KPAs

4.1.2.3 Third Level. ECAC influence elements

The ECAC influence elements are an intermediate level between the Airport, TMA, En-route ECAC influence elements and the Focus Areas. This level represents the ECAC picture in terms of global approach. Not all the exercises outputs have to be integrated into the lower layers, some of the exercises will directly produce ECAC PIs linked to this level.

The initial traceability to the Focus Areas layer from this layer will be created by the Influence Diagrams that will be developed during 2008 and 2009.

4.1.2.4 Fourth Level. Airport, TMA, En-route ECAC influence elements

This layer will be an intermediate level between the Local Performance elements and the higher layers. This level will represent the ECAC picture in terms of global elements but split in the Airport, TMA, En-route areas of the ATM system. Not all the exercises outputs have to be integrated into the Local Performance Indicators layer; some of the exercises will directly produce performance indicators linked at this level.

The initial traceability to the ECAC elements layer from this layer will be created by the Influence Diagrams that will be developed during 2008and 2009.

4.1.2.5 Fifth level. Local Performance influence elements

This layer will be the lowest level of the ECAC Model. This level will represent the local influence elements, for instance a validation exercise about a specific airport could produce the Total Throughput for that airport.

The initial traceability to the Airport, TMA, En-route ECAC Elements layer indicators from this layer will be created by the Influence Diagrams that will be developed during 2008 and 2009.

4.1.3 ECAC Model

The ECAC Model associated to the integration map is the key element to build a performance assessment system. Once the links between the different influence elements among the Performance Framework have been established by the integration map, the ECAC Model will define the nature of the links.

Several techniques will be used to define the nature of the links between the influence elements, the main ones, but not limited to this, will be mathematical models, analytical models and fast time simulation. The following paragraphs focus on the use of a mathematical model for the integration processes inside the Performance Framework.

A mathematical model in the Performance Framework will be composed of two elements, the first one will be a probability distribution for the elements of a layer in the ECAC Model and the second one will be the mathematical formulae or algorithms associated with the performance indicators of the higher layer.

The probability distribution will give an idea of the possible values of the indicator. It will also be used to address the uncertainty associated to this value. The uncertainty of the measurements needs to be propagated using the influence on the final Performance Indicator. These process inaccuracies of the ECAC Model of the influence have to be considered as well. The final result will be the most probable value for the PI together with a range of confidence.

The mathematical formula or algorithm associated with a variable in a higher layer will describe the calculation needed to obtain the value of those performance indicators using as variables the performance indicators of lower layers. Through the traceability developed in the integration map it will be possible to establish which performance indicators have an influence on performance indicators of higher layers.

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The main tasks to fill a part of the ECAC Model using a mathematical model are:

- Assign the probability distribution of the performance indicators or variables. Note that it may be a number not a distribution;
- Establish the formulae or algorithms to calculate the value of a performance indicator based on the lower level PIs. This is a fundamental part of the ECAC Model. Sometimes there will not be an evident mathematical formula. When possible, if there is no mathematical formula or algorithm an alternate method will be proposed e.g. Limited simulation.

It is not an easy task to derive the probability distributions and the algorithms needed by the mathematical model of the ECAC Model, in order to help the research process the Performance Framework has identified the following techniques to support these tasks.

- Simulation exercises results;
- Expert Groups;
- Modelling;
- Gather information from past projects.

To clarify how a mathematical model is applied to the ECAC Model, the following shows how the ECAC Model would work with a case about Fuel Efficiency focus area. The example shows the integration process from the performance indicators at the Airport, TMA, En-route ECAC PIs into the performance indicator of the ECAC PIs layer. Notice that this is not a real example; It uses neither real data nor real formulae.

In this example the following names will be assigned:

W → Fuel consumption for flight in Airport;

X → Fuel consumption for flight in TMA;

Y → Fuel consumption for flight in En-route;

Z → Fuel consumption for flight in ECAC Level.

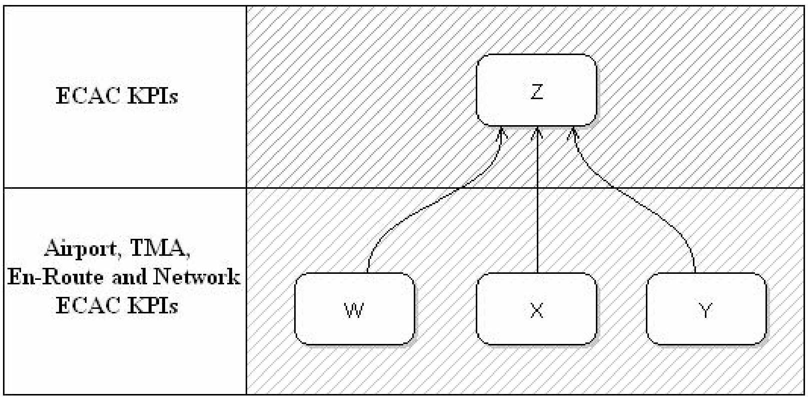


Figure 4-2. Influence between the layers of the ECAC Model

The variables W, X and Y will have range of values, this range is modelled using different probability distributions with their associated coefficients that will modify the shape of the distribution.

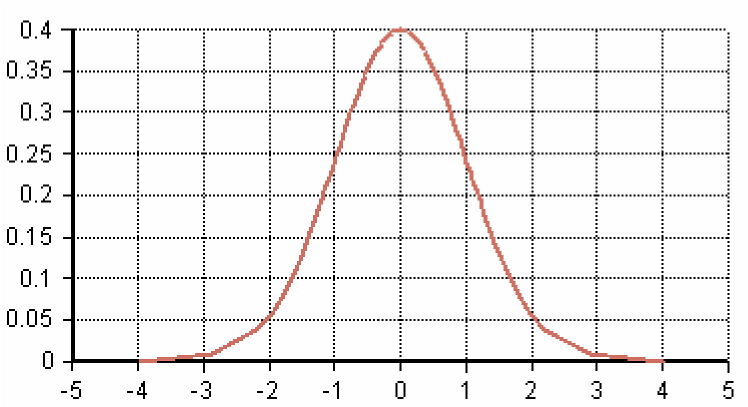
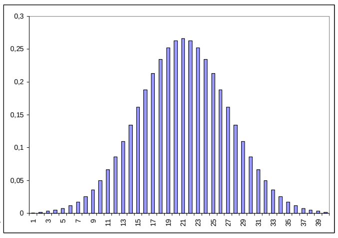
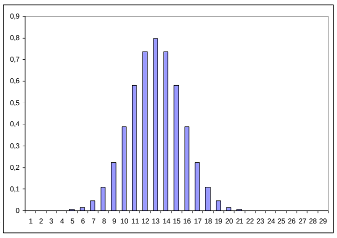
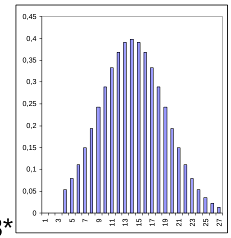
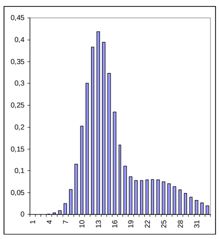


Figure 4-3. Example of Normal Probability Distribution

The next step to get the value of Z would be to find the formula that provides the value of Z. In this case, it could be the sum of the variables that have an influence in Z, weighted by a coefficient, a1, a2, a3 (more influence will imply a higher coefficient).

Z =a1*  +a2*  +a3* 

If a1=0.3, a2=0.5 and a3=0.2 then:

Z= 

The mathematical formula can be very complex, for instance non-measurable factors could be added to the formula as noise effects. This is a simple example. The next section provides wider examples.

4.2 Integration of the EP3 validation exercises in the Performance Framework

In order to have a common understanding of the validation exercises, the Catalogue of Performance Indicators defined in section 5 and the Catalogue of PIs and Traceability of OI Step vs ECAC PIs (Ref [10] and Annex III) should be used in all exercises. This catalogue will allow all the partners in EP3 and outside the project to speak the same language.

After adopting the Catalogue of Performance Indicators as a common way to handle the information coming from the exercise, the next step required in the exercises is to clearly define the scope of the simulation, discriminating between a local and a global approach. The catalogue provides global and local indicators that the exercises can use as outputs, but in the case that the exercises need/provide other indicators outside the catalogue, then a transformation process from indicators outside the catalogue into indicators inside the catalogue would be necessary to feed the ECAC Model with proper information

The EP3 project will provide a model that supports the SESAR operational concept focused on the 2020 timeframe by concentrating on the Second implementation package envisaged in SESAR.

However, EP3 validation exercises consider:

- Limited sets of OI steps (not all OIs proposed by the Target Concept);
- Limited operational contexts.

Therefore, an integration process to obtain an initial approach to the global assessment of the performance of the operational concept against the targets is needed.

The first step of this process will consist in the integration of the results obtained by the validation exercises in each Work Package to obtain a global view on the performance of the Target Concept at Airport, TMA, En-route levels.

The following example tries to clarify this process focusing on airport capacity. It shows how to integrate results provided by the individual validation exercises into a global indicator of Airport Capacity at the ECAC area.

It is not an easy task to provide the probability distribution and the algorithms needed by a mathematical model of the ECAC Model, in order to integrate all the results of the validation exercises. The methodology will be developed later on, producing a first set of influence diagrams that will help to climb up the stairs of the pyramid. These influence diagrams will use as inputs material produced by the SESAR definition phase (T231/D4 assessment), "i.e. past studies, expert judgment".

4.2.1 Integration process example for Airport Capacity

This example is based on the approach defined within SESAR T231 (within the context of D4) to assess the impact of the SESAR Concept on airport capacity. Before going further, the following section provides an overview about the work already done within this SESAR task.

4.2.1.1 SESAR T231/D4 Assessment on Airport Capacity

The purpose of this assessment is to assess the extent to which SESAR can raise potential airport capacities and the effect that this is likely to have across the network in accommodating traffic demand.

The approach basically follows the steps described below:

- Classification of airports in the ECAC Area (relevant for capacity);
- Applicable OIs steps;
- Assessment of the impact of these OIs in each airport category in terms of capacity (based on expert judgment);
- Extrapolation to the ECAC Area.

The assessment is based on a forecasted unconstrained demand (based on the Long Term Forecast Scenario A) and varies from airport to airport. The purpose here is to establish how much of the unconstrained demand can be accommodated by Airport capacity enhancements.

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The focus of the assessment has been made on the Runway capacity as this is assumed to be the limiting factor. The assessment does not cover the Turnaround process and assumes that Apron, Taxiway, Stand, and other Airside capacity are not going to be a limiting factor.

The classification of airports used for this assessment is based on those categories provided by the Challenges to Growth 2004 Report [3]: single runway, crossing runways, parallel dependant runways, parallel independent runways, complex airports 2 and complex airports 1.

The Airport Capacity assessment focuses on the following three aspects: the first two steps are based on a detailed analysis of the Top 100 ECAC Airports in the Challenges to Growth 2004 Report[13][3]:

- Contribution to capacity from currently planned expansion of Airport Runway Infrastructure;
- The scope to accommodate forecast future demand within current hourly BiC (Best in class) Airport capacities. This capacity enhancement includes several IP1 OI Steps, which are already partially deployed across the Airport network;
- An assessment of the potential for IP1 and IP2 OI Steps to raise the BIC capacity values for the different Airport types. This step also uses the CTG-2004 Airport sample, with capacity enhancement judgments derived from “expert judgement” based on the Influence Diagram approach to assess OI Steps (for IP1 and IP2).

As already stated before this is an example with hypotheses, that BiC is implemented in all airports is a hypothesis for this example. Final Influence Diagrams will reflect the different choices available for airports.

The set of Operational Improvements affecting airport capacity in IP1 and IP2 have been grouped together in different sets of OIs, and the impact of each group of OIs on airport capacity has been assessed together for each previously defined airport category.

Three different sets of OIs have been assessed both for IP1 and IP2: Set A (“ATC Sequencing & Spacing”), Set B (“Aircraft Time Spent on Runway”) and Set C (“Optimality of use of multiple runways”).

For example for IP1:

- Set of OIs: **Set A “ATC Sequencing & Spacing**”:
    - AO-0301 Cross-wind separation reduction - mainly an Efficiency impact;
    - AO-0302 Time-based separation enhances resilience with potential to make spacing more consistent;
    - AO-0303 Fixed Reduced Separations based on Wake Vortex Prediction;
    - AUO-0501 Visual Contact Approaches;
    - TS-0102 Basic + Enhanced AMAN (Basic is BIC);
    - TS-0202 Basic + Enhanced DMAN - supports procedures needed for time-based flow of arrivals.
- Set of OIs: **Set B “Aircraft Time Spent on Runway”:**
    - AO-0305 RETs;
    - AUO-0701 Use of ROT reduction techniques;
    - AUO-0702 Brake to Vacate.

[13] Accounting for ~85% of all European Airport air traffic movements

- Set of OIs: **Set C "Optimality of use of multiple runway":**
  - AO-0402 Interlaced Take-off / Landing;
  - AO-0403 Optimised Dependent Parallel Ops (Integrated AMAN / DMAN as enabler to achieve benefits for other OIs).

For each airport category, these sets of OIs steps have been assessed through expert judgment (the improvements for Complex airports have been derived "in aggregate").

Impact of this set of OIs:

	Single Rwy	Crossing Rwys	Par Dep Rwys	Par Ind Rwys	Complex 1	Complex 2
Set A ATC Sequencing & Spacing	5%	5%	5%	5%	n/a	n/a
Set B Aircraft Time Spent on Runway	0%	0%	0%	0%	n/a	n/a
Set C Optimality of use of multiple Rwys	x	5%	5%	10%	n/a	n/a

Table 4-3 Impact on Airport Capacity (IP1)

The percentage of capacity increment in each airport category has been calculated for IP1 as: Airport Capacity increment = Average [Set A, Set B] + Set C.

A similar process has been followed when considering OI steps for IP2.

The final result of the assessment is shown in the following table (BiC in 2020 in terms of hourly operations handled by each airport category):

Airport Category	Current BiC	IP1 Uplift	IP2 Uplift	Total	BiC in 2020
Single Runway	50	3%	5%	8%	54
Crossing Runway	55	8%	8%	15%	63
Parallel Dependent Runways	70	8%	23%	30%	91
Parallel Independent Runways	90	13%	5%	18%	106
Complex Airports (2)	100	-	-	18%	118
Complex Airports (1)	125	-	-	30%	163

Table 4-4 Best in Class Airport enhancements[14]

Translating these figures into daily/annual operations handled by the airports at the ECAC Area is not difficult considering the airports classified in each category. At the end of the process, the document provides a global figure of flights that could be accommodated by the airport network at the ECAC Area in 2020:

ECAC Apt Capacity = $PI_{complex1}$*COMPLEX 1 + $PI_{complex2}$*COMPLEX 2 +...+ PI_{single}*SINGLE

(In this example, PI = number of hourly handled operations).

The assessment has the following limitations:

- It is a limited assessment of the Operational Concept since it only addresses IP1 and IP2;

[14] Please note that for a few large airports (Complex 1 and 2 categories), the potential improvement obtained was simply assessed as being similar to the improvement expected for two parallel runways airports. Results derived "in aggregate" from the results of Parallel Dependant and Parallel Independent types)

- It considers (as a basic assumption) that the Airport Capacity is driven by the Runway Capacity which is considered as the most constraining factor;
- It only takes into account those airports with limited capacity to accommodate the expected demand;
- It does not analyse in depth the possible crossing-effects between the different sets of OIs.

4.2.1.2 Integration Process for Airport Capacity

This section will explain several types of validation exercises related to airport capacity, furthermore a method to integrate the local results, that have been obtained in the exercise execution, into the next level of performance indicators according to pyramid of ECAC layers, Figure 1, this means integrate the local results that belong to the “Local PIs” which is the fifth layer of the performance layers, into the fourth layer “Airport, TMA, En-route ECAC PIs”.

As it has been stated before, the EP3 validation exercises on airports will address a limited set of OI steps in a given operational context (see figure below).

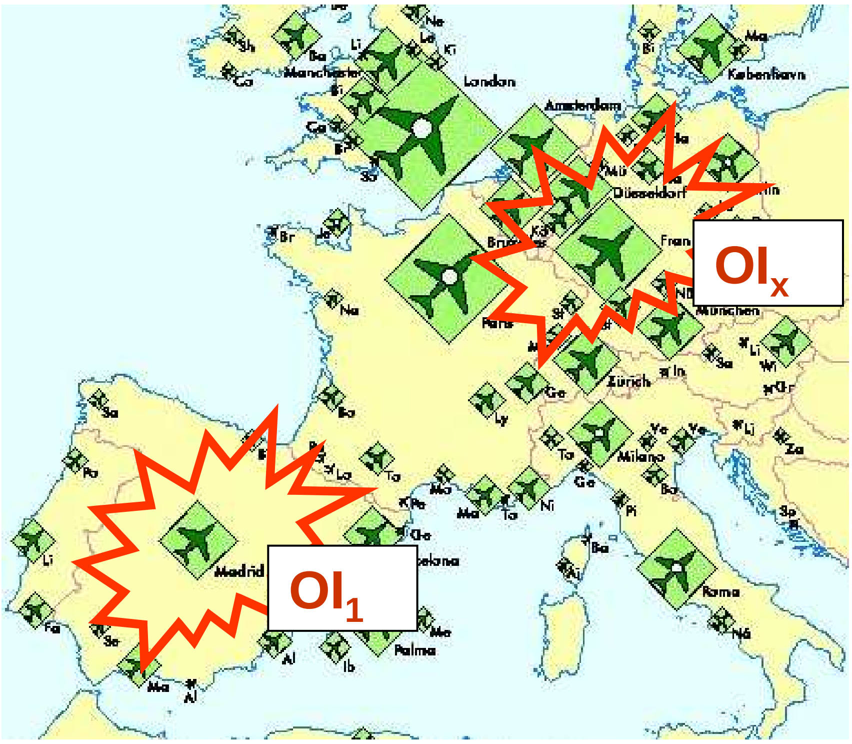

Figure 4-4. EP3 Validation Exercises on Airports

How can those results obtained through these limited number of validation exercises in a limited number of airports and focused on a limited set of OIs be fed into the performance framework to provide a global assessment on airport capacity?

The basic mean to answer this question would be the influence diagrams: they will provide the roadmap to understand the links between the OIs and the KPAs and their influence on the performance of the system. The results obtained by the validation exercises in EP3 will help to verify, reject and even complete the assessment provided by the influence diagrams (based basically on expert judgment).

The influence diagrams to be developed in EP3 will use as inputs those produced within the activities of T231 during the SESAR definition phase. A good starting point consists in analysing how the validation exercises can match with the work already done within the SESAR definition phase.

The following figure shows the influence diagram on airport capacity defined by SESAR T231/D4. The performance assessment done by SESAR T231 considered part of the influence diagram related to airport capacity (red square focused on runway capacity). The assessment has been carried out collectively across the OI Steps relevant to a performance factor in a particular timeframe (or Implementation Package).

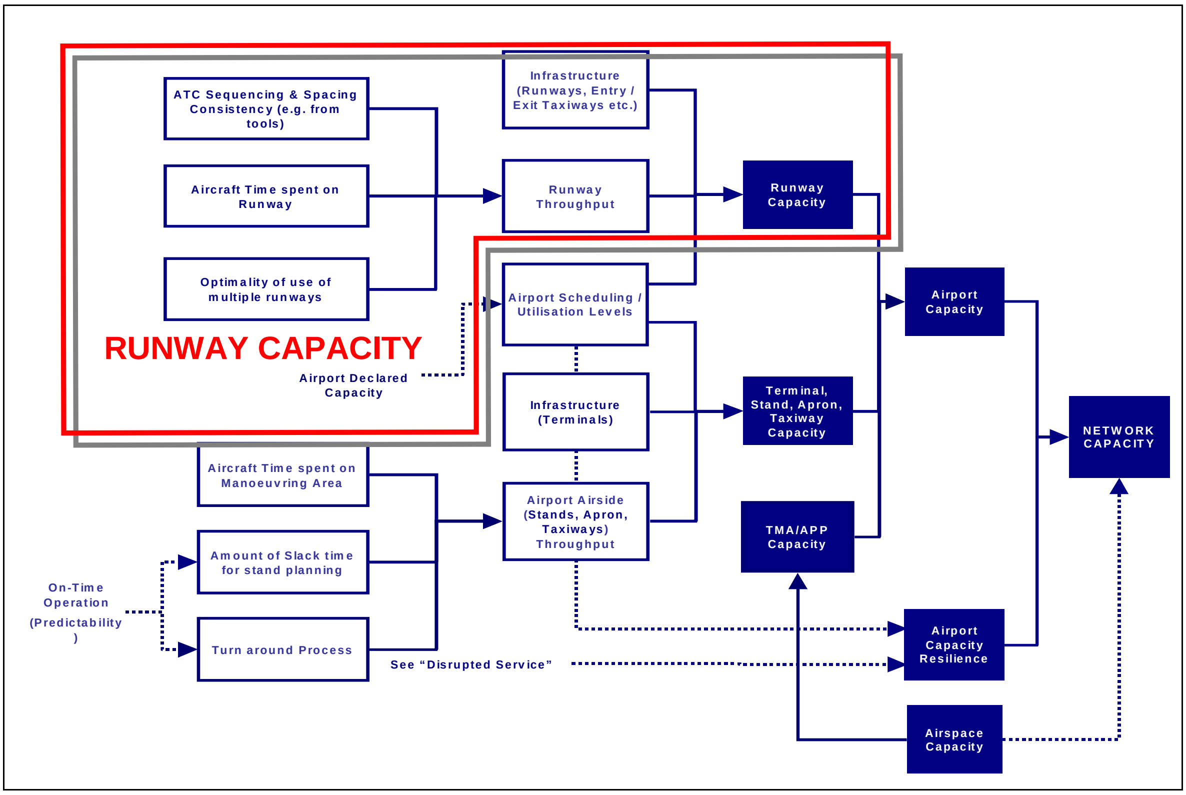

Figure 4-5. SESAR T231 / D4 [15] Influence Diagram "Airport Capacity"

The Table 4-5 represents, for each airport category, the possible impact of each OI step on airport Capacity.

The grey square represents the Sets of OIs assessed in terms of airport capacity in SESAR T231 / D4 in the different airport categories. As it was shown in the previous section, this assessment took into account only a limited number of operational improvements (those OIs affecting runway capacity), but maybe there are other sets of OIs in other areas (for example the turn around process) that could have an influence on airport capacity.

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Airport Category	OI_1	OI_2	OI_3		OI_x			OI_{n-1}	OI_n
Complex 1									
Complex 2									
Parallel Independent Runways									
Parallel Dependent Runways									
Crossing Runways									
Single Runway									

Table 4-5. Impact OIs on Airport Capacity (categories)

Three possible validation exercises are shown on the same table (green, blue and orange areas):

- Exercise 1

Address a set of OIs that has been assessed by SESAR T231 / D4. The results obtained by this type of exercises will help to verify/reject results provided by the expert judgment in SESAR T231;

- Exercise 2

Address a set of OIs not considered by SESAR T231 / D4. They were considered as not relevant from the capacity point of view since they did not affect runway capacity. Therefore this exercise will complete the assessment on airport capacity done by T231;

- Exercise 3

Address three OIs steps in two airport categories. Part of these OIs has been assessed by SESAR T231 / D4 but not the complete set. This exercise will help to complete the assessment made by SESAR T231/D4.

Although WP2, *System Consistency*, is responsible for building the ECAC picture and, therefore, will provide the global framework, there is a need from the other WPs to cooperate in the definition of the performance framework since their results will feed it. All validation exercises have provided the list of OIs that they intend to address. The integration process between the Performance Framework (influence diagrams) and the individual exercises could be done through the OIs list (checking how they match together).

During the development of the methodology and the influence diagrams, the performance framework could help to provide guidelines to the Work packages 3, 4 and 5 during the detailing process of each exercise (for example in terms of the set of OIs addressed by each exercise).

The translation of the local results into daily/annual operations handled by the airports at the ECAC Area can be done following the same process as for SESAR T231. Since the validation exercises address only some airport configurations, the results obtained from them will only affect those airport categories covered in the scope of each exercise while the rest remains the same as in SESAR T231/D4.

Following the same example, the set of validation exercises will contribute to the indicators related to Complex 1 airports and single runway airports.

$$\text{ECAC Apt Capacity} = PI_{complex1}*\text{COMPLEX 1} + PI_{complex2}*\text{COMPLEX 2} +..+ PI_{single}*\text{SINGLE}$$

In this example, PI is the number of hourly handled operations, and the result "ECAC Apt Capacity" is a PI that belongs to the performance indicators layer "Airport, TMA, En-route ECAC PIs", see Figure 2-1. Performance Indicators Layers in the Performance Framework.

Let's take for instance the E3 exercise WP5.3.1.1.3 "Runway Operations FTS":

The objective of this exercise is to measure the impact of the SESAR concept "i.e. Time Based Spacing, Managed Runway Occupancy Time, new Wake Vortex applications, AMAN/DMAN/A-SMGCS" on Runway capacity and provide input to estimating Network capacity at airport level. Therefore it will address a set of Operational Improvements steps already addressed by the T321/D4 assessment.

The exercise aims to provide an initial measurement in different runways configurations and modes of operations on Runway Capacity (and other KPAs): Impact through runway throughput improvement beyond current best-in-class and maintained close to normal even in adverse weather conditions in various runway configurations.

The analysis will be performed considering different groups of runway configurations that are representative of the airport spectrum at ECAC Area. The different modes of operations (segregated operations, mixed operations) and constraints will be also taken into account in this exercise. This could consist of single runway, parallel runways, closely spaced parallel runways, as agreed with the Airport Expert Group.

The results provided by the exercise will verify the performance assessment made by SESAR T231/D4 in terms of runway capacity for the specific runway configurations addressed by the exercise. Those runway configurations not covered will remain invariable respect to SESAR T231.

4.2.1.3 Integration Process for ECAC Capacity

In previous section it has been explained the different types of exercises related to airport capacity that can be performed and the method to integrate the results into the fourth performance indicators layer of the Performance Framework. The next step will be to integrate the capacity figures previously obtained into the next layer, "ECAC PIs" which is the third layer of the pyramid, (see Figure 2-1. Performance Indicators Layers in the Performance Framework).

There are different ways to address this issue, but it is important to take into account that the Influence Diagrams, are not completed yet. The Influence Diagrams will be the source of information that will supply the appropriate method in each particular situation to integrate the PIs of one layer into the PIs of another layer. Keeping in mind that the Influence Diagrams are not completed yet, in the following sections there are two proposals of integration methods with their advantages and disadvantages.

Modelling

The modelling represents the last step of the process to provide a performance assessment of the ECAC area in terms of capacity by integrating the results and participation of WP3, WP4 and WP5. The validation activities within WP3, WP4 and WP5 will be performed in local operational contexts "-e.g. one given airport, TMA". WP2 [20] activities involve ECAC wide modelling and it is necessary to define the link between exercises performed in WP3 [20], WP4 [22] and WP5 [23] and the global ECAC Picture.

For this purpose, **the first step** of the methodology will consist of a high level classification of Airports/TMAs/Airspace in the ECAC Area relevant for capacity according to the application of the Target Concept (OIs). For the rest of KPAs, the categorization of airports/TMAs/airspace may differ from the selected ones for capacity. In any case it will depend on the applicability of the SESAR Concept and will provide the means to extrapolate the assessed benefits of certain concept element/s in certain airport/TMA/airspace to those included in the same airport/TMA/Airspace category. This approach is basically the same as the one applied by SESAR T231 during the airport capacity assessment.

Second step: results provided by WP3 [21], WP4 [22] and WP5 [23] validation exercises will be extrapolated from the local operational context according to the classification of airports/TMAs/airspace identified in the previous step. Figure 4-6 illustrates these first two steps.

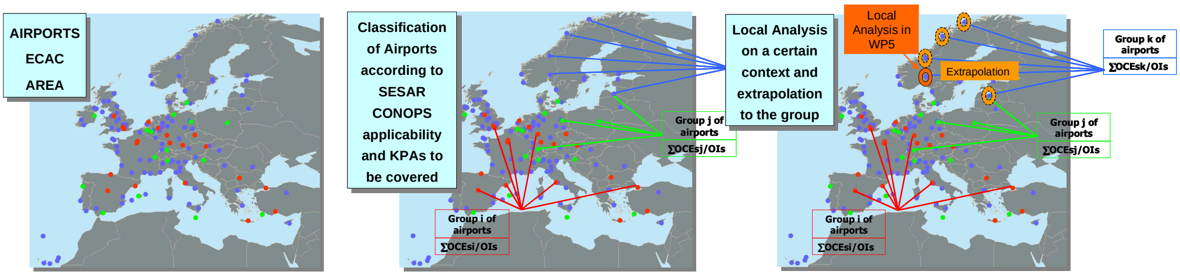

Figure 4-6. Example of methodology application: Airports (steps 1 and 2)

The **third step** of the methodology will consist of the integration of results from the WPs into a model that therefore will provide an initial performance assessment at the ECAC Wide Area, see Figure 4-7. It is foreseen that the model will be able to evolve into a mixture of models, queue model, process models and likely FTS components that intends to perform the ATM ECAC network in high level of detail. Although this will not be performed within EP3.

Since the validation exercises performed in EP3 WPs may not address all related OIs, the assessment could be completed by:

- The set of influence diagrams: they are part of the performance framework and could be the roadmap to build the ECAC assessment;
- The use of past studies;
- Expert judgement.

The model could consist of a set of interrelated nodes with associated constraints (capacities) and fed by a traffic demand and considers the effect of the nodes (individual airports, TMAs, airspace) on the network.

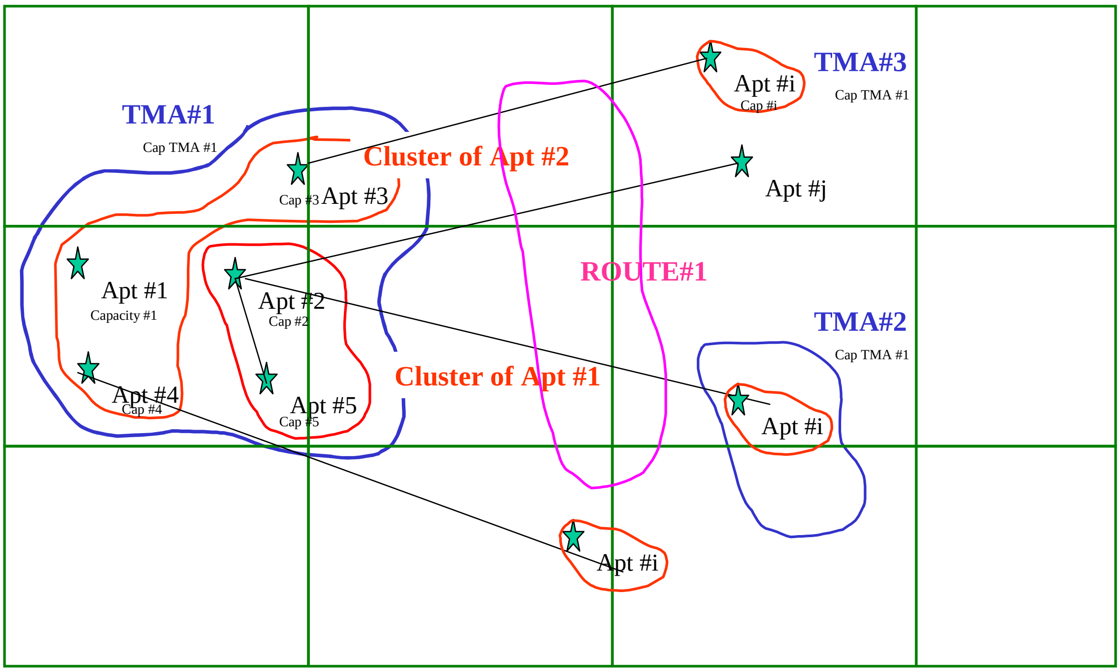

Figure 4-7 Integration of results into model (step 3)

Mathematical formula

The mathematical formulae could be provided by the influence diagrams through expert judgment, by the exercises, or past studies.

For example, the approach to integrate results from Airport ECAC, TMA ECAC and Route ECAC could be based on the same principle used by SESAR T231 in order to obtain airport capacity. The airport consists of several subsystems "-e.g. runway, apron, taxiway, stand and airside". The airport Capacity as a system is defined by the most constraining subsystem in terms of capacity. During the SESAR T231 assessment it was decided that the focus should be made on the Runway capacity as this was assumed to be the limiting factor. Therefore, the assessment did not address e.g. the turnaround process and assumed that Apron, Taxiway, Stand, and other Airside capacity were not going to be a limiting factor.

Following the same methodology, the ECAC capacity should be provided by the most limiting factor from ECAC Airport, ECAC TMA, ECAC Route and ECAC Network:

ECAC Capacity = Minimum [ECAC Airport Capacity, ECAC TMA Capacity, ECAC Route]

This approach does not need modelling but:

- Implies new formulas that should be validated (at least by expert judgment);
- Does not consider the possible effects of the nodes on the performance of the network.

5 CATALOGUE OF PERFORMANCE INDICATORS

This section is a library containing the description of the more useful Performance Indicators identified in each area. This means name, description, and units of measurement. It would be a metrics library to be used by the validation exercises as intermediate values or outputs towards the integration process in order to obtain the appropriate PIs which will be the inputs of the Performance Framework.

At the ECAC level the Performance Targets have been defined by SESAR. Some new targets derived from SESAR's have been established. Nevertheless there are still a lot that need further work to be defined and agreed.

PIs are cluster in the different layers: KPA from ECAC wide perspective, perspective of ECAC TMA, Airport, En-route, and PIs related to local environments.

The uncertainty of the measurements needs to be collected to better assess the range of uncertainty around each measurement. This will be propagated using the influence on the final Performance Indicator. This process inaccuracy of the ECAC Model of the influence has to be considered as well. The final result will be the most probable value for the PI together with a range of confidence.

5.1 ECAC Performance Indicators and their Targets

The Performance Indicators and Performance Targets are going to give the quantitative measures that once integrated will allow measuring of the adequacy of SESAR.

The Performance Indicators that have been taken into account are the ones identified or derived from the SESAR Task 212.

5.1.1 ECAC Performance Indicators for Capacity

5.1.1.1 Objectives

This KPA addresses the ability of the ATM System to cope with air traffic demand (in number and distribution through time and space).

As defined in previous paragraphs the PIs herein established address the ATM System to cope with air traffic demand in number and distribution through time and space.

5.1.1.2 Proposed Indicators

CAP.ECAC.PI 1: Annual number of IFR flights in Europe. Annual number of IFR flights that can be accommodated in Europe.

CAP.ECAC.PI 1.TG: 2020, The European ATM system will need to be able to handle 70% more flights per year than in 2005. This corresponds to 16 million flights.

CAP.ECAC.PI 2: Daily number of IFR flights in Europe. Daily number of IFR flights that can be accommodated in Europe.

CAP.ECAC.PI 2.TG: 2020 target: 49,000 flights/day; 2020+ target: 73,000 flights/day by the end of the design life of the Target Concept.

CAP.ECAC.PI 3: Hourly throughput overloads. Hourly throughput overloads, number of occurrences of capacity (hourly throughput) overloads by overload level per sector/airport/ point.

CAP.ECAC.PI 3.TG: Target not proposed by SESAR / available.

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5.1.2 ECAC Performance Indicators for Environment

5.1.2.1 Objectives

This KPA addresses the ability of the future ATM System to reduce the environmental impact per flight by air traffic management measures.

5.1.2.2 Proposed Indicators

ENV.ECAC.PI 1: Fuel burnt. Total annual amount of fuel burnt divided by number of movements.

ENV.ECAC.PI 1.TG: Reduction by 10% of the total amount of fuel burnt.

ENV.ECAC.PI 2: Annual CO_2. Total annual amount of CO_2 divided by number of movements.

ENV.ECAC.PI 2.TG: Reduction by 10% of the annual amount of CO_2.

ENV.ECAC.PI 3: Annual H_2O. Total annual amount of H_2O divided by number of movements.

ENV.ECAC.PI 3.TG: Reduction by 10% of the annual amount of H_2O.

ENV.ECAC.PI 4: Annual SO_x. Total annual amount of SO_x divided by number of movements.

ENV.ECAC.PI 4.TG: Reduction by 10% of the annual amount of SO_x.

ENV.ECAC.PI 5: Annual NO_x. Total annual amount of NO_x divided by number of movements.

ENV.ECAC.PI 5.TG: Reduction by 10% of the annual amount of NO_x.

ENV.ECAC.PI 6: Annual HC. Total annual amount of HC divided by number of movements.

ENV.ECAC.PI 6.TG: Reduction by 10% of the annual amount of HC.

ENV.ECAC.PI 7: Annual CO. Total annual amount of CO divided by number of movements.

ENV.ECAC.PI 7.TG: Reduction by 10% of the annual amount of CO.

5.1.3 ECAC Performance Indicators for Safety

5.1.3.1 Objectives

To evaluate the Safety of the future ATM System.

5.1.3.2 Proposed Indicators

SAF.ECAC.PI 1: Overall Number of accidents.

SAF.ECAC.PI 1.TG: Absolute number of accident with ATM contribution should not increase and where possible decrease.

SAF.ECAC.PI 2: Accidents per category. Overall Number of accidents per category (Mid-air collisions (MAC), Controlled Flight Into Terrain (CFIT), Wake Turbulence, Runway Collisions, Taxiway Collisions).

SAF.ECAC.PI 2.TG: Safety improvements over the period to at least offset any adverse effects from the increase in traffic.

SAF.ECAC.PI 3: Incidents. Total ATM related incidents (Occurrence per million flight hours and severity).

SAF.ECAC.PI 3.TG: High risk bearing incidents to decrease both in absolute numbers and as a proportion of the total numbers of incidents.

SAF.ECAC.PI 4: Separation Minima Infringements.

SAF.ECAC.PI 4.TG: Improvement in this risk metric to keep absolute annual risk at least constant.

SAF.ECAC.PI 5: Near Controlled Flight into Terrain.

SAF.ECAC.PI 5.TG: Improvement in this risk metric to keep absolute annual risk at least constant.

SAF.ECAC.PI 6: Runway incursion.

SAF.ECAC.PI 6.TG: Improvement in this risk metric to keep absolute annual risk at least constant.

SAF.ECAC.PI 7: Runway excursion.

SAF.ECAC.PI 7.TG: Improvement in this risk metric to keep absolute annual risk at least constant.

SAF.ECAC.PI 8: Runway Confusion.

SAF.ECAC.PI 8.TG: Improvement in this risk metric to keep absolute annual risk at least constant.

SAF.ECAC.PI 9: Unauthorised Penetration of Airspace.

SAF.ECAC.PI 9.TG: Improvement in this risk metric to keep absolute annual risk at least constant.

SAF.ECAC.PI 10: Aircraft Deviation from ATC clearance.

SAF.ECAC.PI 10.TG: Improvement in this risk metric to keep absolute annual risk at least constant.

SAF.ECAC.PI 11: ATM functions related occurrences. Occurrences related to ATM support functions (COM, SUR, NAV, Data processing, Information).

SAF.ECAC.PI 11.TG: Decrease in risk-bearing occurrence.

SAF.ECAC.PI 12: SMS maturity and Safety culture.

SAF.ECAC.PI 12.TG: Safety Management best practices development and safety culture at both managerial and ATCO level (Safety Culture enhancement and measurement tools to come from the European Safety programme (ESP).

5.1.4 ECAC Performance Indicators for Efficiency

5.1.4.1 Objectives

To evaluate the Efficiency of Operational Improvements that are going to be implemented with SESAR, a set of performance indicators is defined below.

5.1.4.2 Proposed Indicators

EFF.ECAC.PI 1: Percent of flight departure on time.

EFF.ECAC.PI 1.TG: On-time departure performance: 1.Occurrence (Punctuality): at least 98% of flights departing on time.

EFF.ECAC.PI 2: Average departure delay per flight.

EFF.ECAC.PI 2.TG: The average departure delay of delayed flights will not exceed 10 minutes.

EFF.ECAC.PI 3: Percent of flights with normal flight duration.

EFF.ECAC.PI 3.TG: More than 95% of flights with normal flight duration.

EFF.ECAC.PI 4: Average extra flight duration.

EFF.ECAC.PI 4.TG: Average flight duration extension of flights will not exceed 10 minutes.

EFF.ECAC.PI 5: Percent of flights suffering additional fuel consumption of more than 2.5%.

EFF. ECAC.PI 5.TG: Less than 5% of flights suffering additional fuel consumption of more than 2.5%.

EFF.ECAC.PI 6: Percent of additional fuel consumption for flight of more than 2.5%.

EFF.ECAC.PI 6.TG: For flights suffering additional fuel consumption of more than 2.5%, the average additional fuel consumption will not exceed 5%.

5.1.5 ECAC Performance Indicators for Predictability

5.1.5.1 Objectives

This KPA addresses the ability of the ATM System to ensure a reliable and consistent level of 4D trajectory performance. In other words: across many flights, the ability to control the variability of the deviation between the *actually flown 4D trajectories* of aircraft in relationship to the *Reference Business Trajectory*.

5.1.5.2 Proposed Indicators

PRED.ECAC.PI 1: Percentage of delayed flights. Percentage of flights delayed at arrival more than 3 minutes.

PRED.ECAC.PI 1.TG: Arrival punctuality: less than 5% (ECAC-wide annual average) of flights suffering arrival delay of more than 3 minutes.

PRED.ECAC.PI 2: Average of delayed flights. Average delay of flights suffering delay of more than 3 minutes.

PRED. ECAC.PI 2.TG: Arrival delay: the average delay (ECAC-wide annual average) of delayed flights (with a delay penalty of more than 3 minutes) will be less than 10 minutes.

PRED.ECAC.PI 3: The coefficient of variation of gate-to-gate time intervals.

PRED.ECAC.PI 3.TG: Coefficient of variation is 0.015.

PRED.ECAC.PI 4: Number of cancelled flights.

PRED.ECAC.PI 4.TG: Reduce cancellation rates by 50% by 2020 compared to 2010 baseline.

PRED.ECAC.PI 5: Number of diverted flights.

PRED.ECAC.PI 5.TG: Reduce diversion rates by 50% by 2020 compared to 2010 baseline.

PRED.ECAC.PI 6: Total delay due to disruption.

PRED.ECAC.PI 6.TG: Reduce total disruption delay by 50% by 2020 compared to 2010 baseline.

PRED.ECAC.PI 7: Number of reactionary delay.

PRED.ECAC.PI 7.TG: Reduce reactionary delay by 50% by 2020 compared to 2010 baseline.

5.1.6 ECAC Performance Indicators for Flexibility

5.1.6.1 Objectives

To evaluate the Flexibility of Operational Improvements that are going to be implemented with SESAR, a set of performance indicators is defined below.

5.1.6.2 Proposed Indicators

FLX.ECAC.PI 1: Frequency of BDT update because trajectory full re-definition: % of Business Trajectory update accepted possibly with time penalty as a consequence of the Business Trajectory full re-definition.

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FLX.ECAC.PI 1.TG: At least 95% (ECAC-wide annual average) of the (valid) requests for full Reference Business Trajectory (RBT) redefinition of scheduled and non-scheduled flights will be accommodated, albeit possibly with a time penalty.

FLX.ECAC.PI 2: Frequency of BDT delayed because trajectory full re-definition: % of Business Trajectory delayed more than 3 minutes as a consequence of the Business Trajectory full re-definition.

FLX.ECAC.PI 2.TG: Of the scheduled and non-scheduled flights with a successfully accommodated request for full RBT redefinition, no more than 10% (ECAC-wide annual average) will suffer a delay penalty of more than 3 minutes (with respect to their requested time) as a consequence of the request.

FLX.ECAC.PI 3: Delay severity because trajectory full re-definition: Average delay of delayed flights as a consequence of the Business Trajectory full re-definition.

FLX.ECAC.PI 3.TG: The average delay (ECAC-wide annual average) of such scheduled and non-scheduled flights (with a delay penalty of more than 3 minutes) will be less than 5 minutes

FLX.ECAC.PI 4: % of non-scheduled flights delayed more than 3 minutes.

FLX.ECAC.PI 4.TG: At least 98% (ECAC-wide annual average) of the non-scheduled flight departures will be accommodated with a delay penalty less than 3 minutes.

FLX.ECAC.PI 5: Average delay of delayed non-scheduled flights.

FLX.ECAC.PI 5.TG: The average delay (ECAC-wide annual average) of such non-scheduled flight departures (with a delay penalty of more than 3 minutes) will be less than 5 minutes.

FLX.ECAC.PI 6: % of the VFR-IFR change requests accommodated without penalties.

FLX.ECAC.PI 6.TG: At least 98% (ECAC-wide annual average) of the VFR-IFR change requests will be accommodated without penalties.

FLX.ECAC.PI 7: Proportion of Airspace Designated Segregated. Provides a yearly indication of airspace designated as segregated as a percentage of the nations total airspace (Geographical Surface of Segregated Areas Area against Published Times over total Amount of Airspace).

FLX.ECAC.PI 7.TG: Target not proposed by SESAR / available.

FLX.ECAC.PI 8: Utilization of Airspace. Give a measurement for segregated areas of time actually used for military flying training compared to the total time available for military training (Total Airspace Capacity available/requested/allocated/used).

FLX.ECAC.PI 8.TG: Target not proposed by SESAR / available.

5.2 ECAC Performance Indicators and targets for Airport, TMA and En-route

The Performance Indicators and Performance Targets are going to give the quantitative measures that integrated will allow measuring the adequacy of SESAR.

The Performance Indicators that have been taken into account are the ones identified in SESAR Task 212.

5.2.1 ECAC Performance Indicators for Airport

5.2.1.1 Proposed PIs for Airport Capacity

CAP.ECAC.APT.PI 1: Annual number of IFR flights that can be accommodated at Airport level.

CAP.ECAC.APT.PI 1.TG: Target not proposed by SESAR / available.

CAP.ECAC.APT.PI 2: Daily number of IFR flights that can be accommodated at Airport level between 0700 and 2200 hrs local time.

CAP.ECAC.APT.PI 2.TG: Target not proposed by SESAR / available.

CAP.ECAC.APT.PI 3: Hourly capacity (number of IFR flights that can be accommodated at Airport level per hour).

CAP.ECAC.APT.PI 2.TG: Target not proposed by SESAR / available.

5.2.1.2 Proposed PIs for Airport Environment

Local Air Quality

For the ECAC wide large scale assessment of the Local Air quality situation the LTO cycle of all movements will be included in the assessment during EP3. The Baseline assessment should assume ISA conditions and standard ICAO LTO parameters. Last could be varied to parameterize the changes caused by the different new SESAR concept elements

ENV.ECAC.APT.PI 1: Amount of CO_2 emitted below 3000ft per flight movement (average).

ENV.ECAC.APT.PI 2: Amount of NO_x emitted below 3000ft per flight movement (average).

ENV.ECAC.APT.PI 3: Amount of SO_x emitted below 3000ft per flight movement (average).

ENV.ECAC.APT.PI 4: Amount of CO emitted below 3000ft per flight movement (average).

ENV.ECAC.APT.PI 5: Amount of HC emitted below 3000ft per flight movement (average).

ENV.ECAC.APT.PI 6: Amount of PM_{10} emitted below 3000ft per flight movement (average).

ENV.ECAC.APT.PI 7: Amount of $PM_{2.5}$ emitted below 3000ft per flight movement (average).

ENV.ECAC.APT.PI 8: Surface areas where those pollutants exceed elementary limits (concentration maps on annual average).

ENV.ECAC.APT.PI 9: Number of Population inside those surface areas (population maps frozen at Baseline year to exclusively capture aviation influence).

5.2.1.3 Proposed PIs for Airport Safety

Foreword (applies similarly to sections 5.2.2.3 and 5.2.3.3):

From the SRC Annual Safety Report[4]: Although analysis shows at European level a higher number of occurrences reported and investigated resulting in a better and more accurate reporting system, there is still a need to improve the national and European reporting levels. The level of reporting still varies significantly between States and with time, and under-reporting is still an issue. Building on this, at the level of details covered in sections 5.2.1.3, 5.2.2.3 and 5.2.3.3, it is difficult to deliver quantitative safety performance indicators. In those sections, at present, indicators are qualitative. The key question during SESAR, when OIs are being implemented, will be whether real safety is improving sufficiently to counter-balance increasing traffic capacity and complexity. This requires two tools: an integrative model of air traffic safety that can predict safety improvements according to OIs/LoCs, and an objective feedback mechanism that can tell us if those predictions were right. The prototype of the model (called the accident/incident model) already exists and is undergoing validation and refinement. Work on defining and developing feedback mechanisms will start in 2009. These two tools will allow true and effective real-time management of safety throughout the SESAR CONOPS Development and Implementation, thereby enabling a comparison against quantified performance indicators as indicated in section 5.1.3.

Runway Collision:

SAF.ECAC.APT.PI 1: Potentially Conflicting Runway Configuration:

- Runway crossing movement, i.e. crossing of runways to reach the terminal or another departure runway;
- Runway entry at intermediate location. Most aircraft enter the runway at the end. Planned entry at an intermediate point introduces the possibility of incursion ahead of other traffic. It may result from short take-off aircraft, including helicopters, being allocated intermediate entry to reduce taxiing or congestion;
- Alternating take-off and landing traffic, i.e. runways used for both take-offs and landings;
- Incorrect runway entry point, i.e. unintentional runway entry at the wrong place. It may result from:
  - Entry at the end of the wrong runway;
  - Unintended entry of the runway through an intermediate taxiway or intersection.

SAF.ECAC.APT.PI 1. TG: Target not proposed by SESAR / available.

SAF.ECAC.APT.PI 2: Premature Take-off.

SAF.ECAC.APT.PI 2. TG: Target not proposed by SESAR / available.

SAF.ECAC.APT.PI 3: Ineffective Take-Off procedures:

- Inadequate take-off instructions by ATCO. This may result from the same causes as above;
- Inadequate communication with pilot;
- Pilot failure to follow the take-off instructions. This may be due to:
  - Take-off without clearance;
  - Failure to advise ATC if holding on the runway.

SAF.ECAC.APT.PI 3. TG: Target not proposed by SESAR / available.

SAF.ECAC.APT.PI 4: Ineffective Runway entry procedures:

- Inadequate runway entry instructions by ATCO. This may result from:
  - Inadequate information to identify conflicts. Since both radar and non-radar surveillance are normally used in combination, this requires an inadequate radar traffic picture combined with inadequate non-radar position information, which may consist of:

    - Inadequate aircraft position reports. For example, where the flight crew is lost and the ATCO fails to clarify the position reports. Another example might be the aircraft holding on the runway after receiving take-off clearance but not advising the ATCO;

    - Inadequate airport ATCO coordination;
  - Inadequate information from approach controller;
  - Inadequate information from ground controller;
- ATCO error in providing runway entry instructions, given the availability of adequate information. The causes of this are categorised as:
  - Failure to recognise runway conflict *-e.g. ATCO not being aware that two aircraft are on the runway;*
  - Misjudgement of runway separation *-e.g. ATCO being aware of the aircraft but incorrectly judging that separation would be maintained*.

- Inadequate communication with pilot. This is where the ATCO decides on appropriate instructions but fails to ensure the pilot receives and implements them;
- Pilot error in runway entry. This may be due to:
  - o Failure to follow the correct taxi route to the runway entry point;
  - o Failure to follow the runway entry instructions.

SAF.ECAC.APT.PI 4. TG: Target not proposed by SESAR / available.

SAF.ECAC.APT.PI 5: Ineffective Conflict warning:

- Conflict warning system not present;
- Conflict warning system fails to give warning in time;
- Controller failure to respond to warning;
- Controller failure to resolve conflict in time. This may be due to:
  - o Failure to communicate appropriate avoidance instructions;
  - o Pilot failure to take the instructed avoidance action.

SAF.ECAC.APT.PI 5. TG: Target not proposed by SESAR / available.

SAF.ECAC.APT.PI 6: Ineffective Collision avoidance:

- Ineffective avoidance warning by ATCO:
  - o Low visibility prevents conflict detection;
  - o Darkness prevents conflict detection;
  - o Restricted view from tower prevents conflict detection;
  - o ATCO failure to see visible aircraft in time;
  - o ATCO failure to resolve conflict in time;
- Ineffective avoidance by intruding aircraft;
- Ineffective avoidance by impeded aircraft.

SAF.ECAC.APT.PI 6. TG: Target not proposed by SESAR / available.

Taxiway Collision:

SAF.ECAC.APT.PI 7: Inadequate ground movement clearance.

SAF.ECAC.APT.PI 7. TG: Target not proposed by SESAR / available.

SAF.ECAC.APT.PI 8: Ground movement procedures unable to ensure separation.

SAF.ECAC.APT.PI 8. TG: Target not proposed by SESAR / available.

SAF.ECAC.APT.PI 9: Ineffective avoidance on striking aircraft.

SAF.ECAC.APT.PI 9. TG: Target not proposed by SESAR / available.

5.2.1.4 Proposed PIs for Airport Efficiency

EFF.ECAC.APT.PI 1: Percentage of flights departing on time / On-time departure performance at the airport: "-e.g. on-time departure is defined as actual off-block departure less than 3 minutes before or after the departure time of the Initial Shared Business Trajectory; delayed departure is defined as actual departure more 1 minute, 2 minutes, 3 minutes or more after the departure time of the Initial Shared Business Trajectory".

EFF.ECAC.APT.PI 1.TG: Occurrence (punctuality); Target not proposed by SESAR / available.

EFF.ECAC.APT.PI 2: Average departure delay of delayed flights /On-time departure performance at the airport: "-e.g. on-time departure is defined as actual off-block departure less than 3 minutes before or after the departure time of the Initial Shared Business Trajectory; delayed departure is defined as actual departure more than 1 minute, 2 minutes, 3 minutes or more after the departure time of the Initial Shared Business Trajectory".

EFF.ECAC.APT.PI 2.TG: Severity (Delays): Target not proposed by SESAR / available.

EFF.ECAC.APT.PI 3: Percentage of flights with normal flight duration / Flight duration efficiency at the airport "-e.g. normal flight duration is defined as actual block-to-block time less than 3 minutes longer than the block-to-block time of the Initial Shared Business Trajectory; extended flight duration is defined as actual block-to-block time more than 1 minute, 2 minutes, 3 minutes or more longer than the block-to-block time of the Initial Shared Business Trajectory". This PI will be focused on the flight duration efficiency during the airport phase (airport origin + airport destination).

EFF.ECAC.APT.PI 3.TG: Occurrence; Target not proposed by SESAR / available.

EFF.ECAC.APT.PI 4: Average flight duration extension / Flight duration efficiency at the airport "-e.g. normal flight duration is defined as actual block-to-block time less than 3 minutes longer than the block-to-block time of the Initial Shared Business Trajectory; extended flight duration is defined as actual block-to-block time more than 1 minute, 2 minutes, 3 minutes or more longer than the block-to-block time of the Initial Shared Business Trajectory". This PI will be focused on the flight duration efficiency during the airport phase (airport origin + airport destination).

EFF.ECAC.APT.PI 4.TG: Severity: Target not proposed by SESAR / available.

EFF.ECAC.APT.PI 5: Percentage of flights suffering additional fuel consumption of more than 2.5% at the airport / Gate to Gate fuel efficiency: Actual compared to Initial Shared Business Trajectory. This PI will be focused on the fuel efficiency during the airport phase (airport origin + airport destination).

EFF.ECAC.APT.PI 5.TG: Occurrence; Target not proposed by SESAR / available.

EFF.ECAC.APT.PI 6: Average additional fuel consumption of flights suffering additional fuel consumption of more than 2.5% at the airport / Gate to Gate fuel efficiency: Actual compared to Initial Shared Business Trajectory. This PI will be focused on the fuel efficiency during the airport phase (airport origin + airport destination).

EFF.ECAC.APT.PI 6.TG: Severity: Target not proposed by SESAR / available.

5.2.1.5 Proposed PIs for Airport Predictability

PRED.ECAC.APT.PI 1: Arrival Punctuality: Percentage of Flights delayed at arrival at Airport level "-i.e. especially those delayed more than 1 minute, 2 minutes, 3 minutes".

PRED.ECAC.APT.PI 1.TG: Target not proposed by SESAR / available.

PRED.ECAC.APT.PI.2: Average delay of delayed flights at airport level "-i.e. especially those delayed more than 1 minute, 2 minutes, 3 minutes".

PRED.ECAC.APT.PI 2.TG: Target not proposed by SESAR / available.

5.2.1.6 Proposed PIs for Airport Flexibility

FLX.ECAC.APT.PI 1: Average delay of delayed flights as a consequence of the Business Trajectory full re-definition at Airport level.

FLX.ECAC.APT.PI 1.TG: Target not proposed by SESAR / available.

FLX.ECAC.APT.PI 2: Average delay of delayed non-scheduled flights at Airport level.

FLX.ECAC.APT.PI 2.TG: Target not proposed by SESAR / available.

FLX.ECAC.APT.PI 3: Percentage of delayed flights due to a Business trajectory update: Measurement of the airport flexibility to accommodate flights that have updated their Business Trajectory. It is the percentage of flights with a business trajectory update delayed more than 1 minute, 2 minutes, 3 minutes or more.

FLX.ECAC.APT.PI 3.TG: Target not proposed by SESAR / available.

FLX.ECAC.APT.PI 4: Average delay of delayed flights due to a Business trajectory update at the airport: (minutes/delayed aircraft).

FLX.ECAC.APT.PI 4.TG: Target not proposed by SESAR / available.

FLX.ECAC.APT.PI 5: Percentage of VFR-IFR change requests accommodated without penalties.

FLX.ECAC.APT.PI 5.TG: Target not proposed by SESAR / available.

5.2.2 ECAC Performance Indicators for TMA

In this section, PIs relevant for TMA experiments are described. PIs with no identification are not presentable as a value (map, diagram), but are still valuable.

A set of indicator results is linked to a scenario which has a *geographic area* and *duration*.

The **duration** could last 15 hours in fast time simulation, or 1 year in a more general assessment method for example.

The **geographic area**, where all indicators will be evaluated or computed, should be a grouping of all TMA geographic areas. The geographic area of a TMA should as much as possible start before holdings and Initial Approach Fixes, finish at the intercept point of the glide path + 2 Nm, and exclude transit aircrafts. The geographic area should start for departure after they take off, for example at 800ft. In the capacity section, the geographic area can be replaced by the most penalising sector. This *geographic* area should be the same for all other metrics.

5.2.2.1 Proposed PIs for TMA Capacity

CAP.ECAC.TMA.PI 1: 1h capacity (Nb aircraft/h). Maximum number of aircraft that can exit the geographic area in one hour. It must be measured when the system is overloaded (*or fully loaded, in high traffic conditions*) for a whole hour.

CAP.ECAC.TMA.PI 2: Maximum simultaneous number of aircraft (Nb aircraft). maximum simultaneous aircraft being controlled in the TMA.

CAP.ECAC.TMA.PI 3: Total delays (min): sum of delays, due to the TMAs, for arrivals and for departures. The delay for arrivals is the difference between the planed arrival time and the actual arrival time. The delay for departures is given while it is on the ground.

CAP.ECAC.TMA.PI 4: Total period throughput (Nb aircraft). Total number of aircraft controlled in the TMA during the scenario duration.

CAP.ECAC.TMA.PI 5: Maximum measured throughput (Nb aircraft/h). It is the maximum number of aircraft that actually exited the geographic area, per hour with the considered traffic demand. It is either lower that ECAC TMA capacity or equal to it when the system is fully loaded.

CAP.ECAC.TMA.PI 6: 10min capacity (Nb aircraft). Maximum number of aircraft that can exit the geographic area during a 10 minutes period. The measurement should be based on sector boundaries, rather than radio, in order to reduce grouping effects.

Mean throughput can easily be derived from *total number. Average delay* due to the TMA per aircraft can be computed from *total delays*. Note that delays are mainly intended for Efficiency.

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5.2.2.2 Proposed PIs for TMA Environmental Sustainability

The main part of a TMA is located above 3000ft. The emissions in the TMA depend strongly on the altitude/flight level where the TMA starts and has its ceiling. The TMA of Schiphol airport for instance is divided into six sectors. The starting altitude of the different sectors varies between 1500 ft and 5500ft. If the starting altitude of a TMA-sector is 3000ft or higher a local air quality assessment can not be performed.

To provide ECAC wide sub system information the use of a generic, theoretical TMA, identical for all ECAC TMAs might be a solution. Such approach is for example used by the EUROCONTROL Performance Review Unit, where a TMA is defined as a 30nm radius circle around the airport location (see TMA definition section 1.5 Glossary of terms). Upper and lower limits for such generic TMA could be defined for example by using ECAC average TMA start and ceiling limits.

A similar generic approach could be used for the ECAC wide airport sub system performance, by defining the airport to be zone where flight operations up to 3000ft take place.

ENV.ECAC.TMA.PI 1: Amount of CO_2 emitted below TMA ceiling per flight movement (average).

ENV.ECAC.TMA.PI 2: Amount of NO_x emitted below TMA ceiling per flight movement (average).

ENV.ECAC.TMA.PI 3: Amount of SO_X emitted below TMA ceiling per flight movement (average).

ENV.ECAC.TMA.PI 4: Amount of CO emitted below TMA ceiling per flight movement (average).

ENV.ECAC.TMA.PI 5: Amount of HC emitted below TMA ceiling per flight movement (average).

ENV.ECAC.TMA.PI 6: Amount of PM_{10} emitted below TMA ceiling per flight movement (average).

ENV.ECAC.TMA.PI 7: Amount of $PM_{2.5}$ emitted below TMA ceiling per flight movement (average).

ENV.ECAC.TMA.PI 8: Sum of Surface areas with Noise Level:

- Lden > 55dB day;
- Lnight > 50dB night;
- EFF.ECAC.PI 9.TG: Reduction by 10%.

ENV.ECAC.TMA.PI 9: Total Number of Population ECAC wide exposed to Noise Level:

- Lden > 55dB day;
- Lnight > 50dB night;
- EFF.ECAC.PI 10.TG: Reduction by 10%.

5.2.2.3 Proposed PIs for TMA Safety

SAF.ECAC.TMA.PI 1: Conflict number (no unit) in the TMAs. A conflict here means a potential separation loss. It is approximated as a separation of less than 2,5NM and 800ft that would occur 2 minutes ahead from the moment of observation, if the two aircrafts were maintaining their speed vector. This PI requires realistic tracks, and may therefore not be “easy” to evaluate.

SAF.ECAC.TMA.PI 2: Number of separation losses in the TMAs (no unit). Number of times a pair of aircraft goes below 3NM horizontal and 1000ft vertically. If *conflicts number* can not be evaluated, then this PI will do.

SAF.ECAC.TMA.PI 3: Total overload duration (min). Times the controller is saturated with different severities and therefore, there are risky situations and then safety precursors. It is computed by analysing controller taskload during the day, and counting the cumulated time spent with taskload over a saturation limit. The saturation limit is subjective; it could be 70% of the maximum taskload.

SAF.ECAC.TMA.PI 4: Total underload duration (min); Times the controller has quite nothing to do and therefore, there are risky situations and then safety precursors. It is computed by analysing controller taskload during the day, and counting the cumulated time spent with taskload under a minimal activity limit. The saturation limit is subjective; it could be 15% of the maximum taskload:

- Locations of the conflicts. Density maps could be produced based on this PI;
- Locations of the separation losses. Density maps could be produced based on this PI.

5.2.2.4 Proposed PIs for TMA Efficiency

EFF.ECAC.TMA.PI 1: Total flight duration **(**min). Sum of the flight durations in the scenario. Times during which aircraft are not in the geographic area are not considered. Time during which aircraft are flying before the beginning of the scenario are not considered too.

EFF.ECAC.TMA.PI 2: Optimal total flight duration (min). Sum of the “best controlled” flight durations. The “best controlled” flight duration is the one the aircraft would have if it were alone in the geographic area, following applicable procedures, from the first point of the geographic area to the last point of the geographic area. It can be computed by taking into account aircraft performances. (See the beginning of the ECAC Performance Indicators for TMA section for precisions on the geographic area).

EFF.ECAC.TMA.PI 3: Total Fuel consumption (kg): Fuel consumption in the geographic area. If it is not computable, then fuel consumption can be replaced by the flown distance (Nm).

EFF.ECAC.TMA.PI 4: Optimal total fuel consumption (kg). Sum of the “best controlled” fuel consumptions. The “best controlled” fuel consumption of an aircraft is its fuel consumption that would be used to travel in the geographic area if it was alone, with no other traffic to disturb its trajectory. If not computable, it can be replaced by *total effective distance* in the “general performance indicators” section.

EFF.ECAC.TMA.PI 5: Number of delays (Nb aircraft): Number of aircraft delayed by more that 3 minutes (a delay is the difference between expected time and actual time). Delay information can be found using flight plan data.

EFF.ECAC.TMA.PI 6: Total delays (min): Sum of delays due to the TMA, for arrivals and for departures:

- List of delays per aircraft (min, one value per aircraft). This data will enable the evaluation of several PIs such as the percentage of aircraft delayed for more than 3 minutes, and PIs like *Total delays*, due to the TMA, for arrivals and for departures, or *average delay* due to the TMA per aircraft, evaluated for arrivals and for departures;
- List of flight durations per aircraft (min, one value per aircraft). This data could be used for the same reasons as for the delay list;
- List of fuel consumption per aircraft (kg, one value per aircraft). This data could be used for the same reasons as for the delay list;

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- List of flown distances per aircraft (Nm, one value per aircraft). This data could be used for the same reasons as for the delay list.

5.2.2.5 Proposed PIs for TMA Flexibility

FLX.ECAC.TMA.PI 1: RBT change success (%). Percentage of Business Trajectory that requested a 4D Trajectory change and either could not get it or got an *additional delay* of more than 3 minutes as a consequence, over the number of Business Trajectory that did the request. The *additional delay* is the difference between the time the aircraft actually flew in the geographic area and the time it would have flown if it did not make the request. The amount of incurred *additional delay* has an influence on efficiency indicators.

FLX.ECAC.TMA.PI 2: VFR-IFR change success (%). Percentage of the VFR-IFR change requests accommodated without penalties.

FLX.ECAC.TMA.PI 3: Proportion of Airspace Designated Segregated (%). Provides a yearly indication of airspace designated as segregated as a percentage of the nations total airspace. It is the sum of surfaces of segregated areas (in the geographical area of the scenario) multiplied by the duration of the segregation in hours and by the number of flight levels used, over the surface of the geographical area of the scenario multiplied by 24h and by 400, the whole multiplied by 100.

FLX.ECAC.TMA.PI 4: Adherence to optimum Airspace Dimension (ratio). Gives a proportional measurement of how frequently military training has taken place within airspace areas that conform to the optimum airspace dimension (ratio of Allocated Airspace over Optimum Airspace Dimensions).

FLX.ECAC.TMA.PI 5: Utilization of Airspace (ratio). Gives a measurement for segregated areas of time actually used for military flying training compared to the total time available for military training (Total Airspace Capacity available/requested/allocated/used).

FLX.ECAC.TMA.PI 6: Efficient Booking Procedure (ratio). Gives an indication of actual airspace usage by military users compared with that booked by planners thus providing a measure of the degree of over- or under-booking of airspace by military planners (ratio of Time Used over Time Requested).

FLX.ECAC.TMA.PI 7: Training in Non-Segregated Airspace (ratio). Measures how often military airspace users train in airspace not specifically designed for military training (ratio of Time Spent Training in Non-Segregated Areas over Total Training Time).

FLX.ECAC.TMA.PI 8: Release of Airspace (ratio). Reports on the proportion of flexible use airspace military allocated but not used that was released for civil use on a time basis (ratio of Time given back before Scheduled Start over Time Cancelled).

5.2.2.6 Proposed PIs for TMA Predictability

PRE.ECAC.TMA.PI 1: Unpredictable Deviation (min). *Unpredictable deviation* depends on how airspace users estimate flight times. As it may not have user estimates, it is supposed here that they use the origin/destination parameter (the procedure in TMA), and the type of the aircraft. This is the rational for the *procedure deviation*. This PI enables to take into considerations procedures with different durations, and aircraft with different speeds and it still make the predictability computation valid.

- The *best controlled flight duration* is the one the aircraft would have if it were alone in the TMA, and still following applicable procedures. This is the duration to go from the first point the aircraft has in the geographic area (e.g. an Initial Approach Fix) to the last point the aircraft has in the geographic area (e.g the glide path + 2 Nm). Computing this time can be done with data analysis or with performance data using aircraft type and weight;
- A *deviation for an aircraft* is the difference between its actual flight duration and its *best controlled flight duration* (absolute value);

- A *procedure deviation* is for a specified TMA procedure the average deviations of flights that follow the procedure. This is the estimation an aircraft can make of the deviation it will encounter, knowing the procedure it will follow;
- The unpredictable deviation is the sum of absolute values of (*deviation – procedure deviation*), for all aircraft. If a procedure gives 60 seconds of deviation to all aircraft, it will be very predictable (*procedure deviation* = 60s, sum (deviation – procedure deviation) = sum (60 – 60) = 0, *unpredictable deviation* of procedure = 0);
- The computation is still valid if *best controlled duration* is replaced by the *initial flight plan duration*, the duration of the initial flight plan in the geographic area. What is important is to have a value that can be determined before the day the aircraft takes off. Using AMAN estimates is not appropriate, because this is an interactive value that takes into account other traffic, and which can not be set before the day of operation. For the same reason, the actual flight plan is not usable.

PRE.ECAC.TMA.PI 2: Flight time deviation (no unit). Flight time standard deviation divided by mean flight time. This PI does not capture the fact that sub-groups of trajectories can have regular flight times internally, while their average flight time is different (two different procedures in TMA for example). It also does not capture the fact that aircrafts of different category have different speeds. Those two points could make *flight time deviation* big, while flight times are actually very predictable.

5.2.3 ECAC Performance Indicators for En-route

5.2.3.1 Proposed PIs for En-route Capacity

CAP.ECAC.ER.PI 1: Annual flights accommodated. Annual number of IFR flights that can be accommodated at En-route level.

CAP.ECAC.ER.PI 1.TG: Target not proposed by SESAR / available.

CAP.ECAC.ER.PI 2: Daily flights accommodated. Daily number of IFR flights that can be accommodated at En-route level.

CAP.ECAC.ER.PI 2.TG: Target not proposed by SESAR / available.

CAP.ECAC.ER.PI 3: Hourly throughput overloads. Number of occurrences of capacity (hourly throughput) overloads by overload level per sector or airspace volume level.

CAP.ECAC.ER.PI 3.TG: Target not proposed by SESAR / available.

5.2.3.2 Proposed PIs for En-route Environment

ENV.ECAC.ER.PI 1: ECAC wide total amount of fuel burnt per flight movement (average).

ENV.ECAC.ER.PI 2: ECAC wide total amount of H_2O emitted above 3000ft per flight movement (average).

ENV.ECAC.ER.PI 3: ECAC wide total amount of CO_2 emitted above 3000ft per flight movement (average).

ENV.ECAC.ER.PI 4: ECAC wide total Amount of NO_x emitted above 3000ft per flight movement (average).

ENV.ECAC.ER.PI 5: ECAC wide total Amount of SO_x emitted above 3000ft per flight movement (average).

ENV.ECAC.ER.PI 6: ECAC wide total Amount of CO emitted above 3000ft per flight movement (average).

ENV.ECAC.ER.PI 7: ECAC wide total Amount of HC emitted above 3000ft per flight movement (average).

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5.2.3.3 Proposed PIs for En-route Safety

SAF.ECAC.ER.PI 1: Ineffective traffic synchronisation including:

- No ATC planning;
- Inadequate ATC planning:
  - Inadequate planning information;
  - Inadequate strategic surveillance picture;
  - Inadequate flight plan data.
- Planning controller failure to recognise conflict;
- Planning controller misjudgement of conflict prevention;
- Inadequate planning controller coordination.
- Planning controller failure to alert tactical controller to conflict

SAF.ECAC.ER.PI 1.TG: Target not proposed by SESAR / available.

SAF.ECAC.ER.PI 2: Penetration of controlled airspace:

- Conflict due to military traffic;
- Conflict due to VFR traffic.

SAF.ECAC.ER.PI 2.TG: Target not proposed by SESAR / available.

SAF.ECAC.ER.PI 3: Level bust:

- Level bust due to communication error;
  - Inadequate ATCO transmission of instructions;
  - Inadequate pilot read-back.
- Pilot handling error;
- Altimeter setting error;
- Technical failure in autopilot or navigation equipment;
- ACAS RA;
- Weather induced level bust.

SAF.ECAC.ER.PI 3.TG: Target not proposed by SESAR / available.

SAF.ECAC.ER.PI 4: Trajectory instructions result in conflict.

SAF.ECAC.ER.PI 4.TG: Target not proposed by SESAR / available.

SAF.ECAC.ER.PI 5: Conflict in uncontrolled airspace.

SAF.ECAC.ER.PI 5.TG: Target not proposed by SESAR / available.

SAF.ECAC.ER.PI 6: Inadequate separation instructions:

- Inadequate information for tactical control:
  - Inadequate tactical surveillance picture;
  - Inadequate flight plan data.
- ATCO failure to recognise conflict;
- ATCO misjudgement in tactical separation;
- Inadequate ATCO co-ordination.

SAF.ECAC.ER.PI 6.TG: Target not proposed by SESAR / available.

SAF.ECAC.ER.PI 7: Inadequate communication of instructions to pilot:

- Inadequate ATCO transmission of instructions;
- Loss of communication;
- Inadequate pilot read-back.

SAF.ECAC.ER.PI 7.TG: Target not proposed by SESAR / available.

SAF.ECAC.ER.PI 8: Inadequate pilot response to ATC.

SAF.ECAC.ER.PI 8.TG: Target not proposed by SESAR / available.

SAF.ECAC.ER.PI 9: Inadequate separation instructions:

- Inadequate tactical surveillance picture;
- ATCO failure to recognise conflict in time.

SAF.ECAC.ER.PI 9.TG: Target not proposed by SESAR / available.

SAF.ECAC.ER.PI 10: Inadequate separation instructions to pilot:

- Inadequate ATCO transmission of instructions;
- Loss of communication;
- Inadequate pilot read-back.

SAF.ECAC.ER.PI 10.TG: Target not proposed by SESAR / available.

SAF.ECAC.ER.PI 11: Inadequate pilot response to ATC.

SAF.ECAC.ER.PI 11.TG: Target not proposed by SESAR / available.

SAF.ECAC.ER.PI 12: Ineffective tactical separation of ATCO induced conflict

SAF.ECAC.ER.PI 12.TG: Target not proposed by SESAR / available.

SAF.ECAC.ER.PI 13: Ineffective tactical separation by pilot:

- Inadequate traffic information from ATCO;
- Inadequate communication of information to pilot:
    - Inadequate ATCO transmission of information;
    - Loss of communication;
    - Inadequate pilot read-back.

SAF.ECAC.ER.PI 13.TG: Target not proposed by SESAR / available.

SAF.ECAC.ER.PI 14: Inadequate separation by pilot.

SAF.ECAC.ER.PI 14.TG: Target not proposed by SESAR / available.

SAF.ECAC.ER.PI 15: Ineffective STCA warning:

- No STCA coverage;
- STCA fails to give warning in time;
- Controller fails to respond to STCA warning;
- Controller fails to resolve conflict in time.

SAF.ECAC.ER.PI 15.TG: Target not proposed by SESAR / available.

SAF.ECAC.ER.PI 16: Ineffective other ATCO warning:

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- No independent ATCO monitoring;
- Other ATCOs fail to detect conflict;
- ATCOs fail to communicate warning;
- Controller fails to resolve conflict in time.

SAF.ECAC.ER.PI 16.TG: Target not proposed by SESAR / available.

SAF.ECAC.ER.PI 17: Ineffective ACAS avoidance:

- ACAS not installed;
- ACAS fails to give RA in time;
- Pilot fails to respond to RA in time;
- ACAS avoidance invalidated by other aircraft.

SAF.ECAC.ER.PI 17.TG: Target not proposed by SESAR / available.

SAF.ECAC.ER.PI 18: Ineffective visual avoidance on commercial aircraft:

- Other aircraft effectively invisible;
- Flight crew fail to observe visible aircraft in time;
- Pilot fails to take avoidance action in time;
- Visual avoidance response invalidated by other aircraft.

SAF.ECAC.ER.PI 18.TG: Target not proposed by SESAR / available.

5.2.3.4 Proposed PIs for En-route Efficiency

EFF.ECAC.ER PI 1: Normal flight duration. Percent of flights with normal flight duration at En-route level.

EFF.ECAC.ER PI 1.TG: Target not proposed by SESAR / available.

EFF.ECAC.ER PI 2: Extra flight duration. Average extra flight duration at En-route level.

EFF.ECAC.ER PI 2.TG: Target not proposed by SESAR / available.

EFF.ECAC.ER PI 3: Flights with additional fuel consumption. Percent of flights suffering additional fuel consumption of more than 2.5% at En-route level.

EFF.ECAC.ER PI 3.TG: Target not proposed by SESAR / available.

EFF.ECAC.ER PI 4: Additional fuel consumption. Percent of additional fuel consumption for flight of more than 2.5% at En-route level.

EFF.ECAC.ER.PI 4.TG: Target not proposed by SESAR / available.

EFF.ECAC.ER PI 5: Fuel deviation. Average fuel deviation of deviated flights.

EFF.ECAC.ER.PI 5.TG: Target not proposed by SESAR / available.

5.2.3.5 Proposed PIs for En-route Predictability

PRED.ECAC.ER PI 1: Delayed flights. Percentage of flights delayed at arrival more than x minutes at En-route level (x to be defined).

PRED.ECAC.ER PI 1. Target not proposed by SESAR / available.

PRED.ECAC.ER PI.2: En-route average delay. Average delay of flights suffering delay of more than x minutes at En-route level.

PRED.ECAC.ER PI 2.TG: Target not proposed by SESAR / available.

PRED.ECAC.ER PI 3: En-route average total delay. Average delay of delayed flights.

PRED.ECAC.ER PI 3.TG: Target not proposed by SESAR / available.

PRED.ECAC.ER PI 4: Diverted flights. Number of diverted flights at En-route level.

PRED.ECAC.ER PI 4.TG: Target not proposed by SESAR / available.

5.2.3.6 Proposed PIs for En-route Flexibility

FLX.ECAC.ER PI 1: Average delay due to RBT re-definition. Average delay of delayed flights as a consequence of the Business Trajectory full re-definition at En-route level.

FLX.ECAC.ER PI 1.TG: Target not proposed by SESAR / available.

FLX.ECAC.ER PI 2: Average delay in non-scheduled flights. Average delay of delayed non-scheduled flights at En-route level.

FLX.ECAC.ER PI 2.TG: Target not proposed by SESAR / available.

FLX.ECAC.ER.PI 3: Flights delayed due to RBT update. Percentage of delayed flights due to a Business trajectory update. Measurement of the En-route flexibility to accommodate flights that have updated their Business Trajectory. It is the percentage of flights with a business trajectory update delayed more than 3 minutes.

FLX.ECAC.ER.PI 3.TG: Target not proposed by SESAR / available.

FLX.ECAC.ER.PI 4: Average delay due to RBT update. Average delay of delayed flights due to a Business trajectory update at the En-route level (minutes/delayed aircraft).

FLX.ECAC.ER.PI 4.TG: Target not proposed by SESAR / available.

FLX.ECAC.ER.PI 5: Change requests. Percentage of VFR-IFR change requests accommodated without penalties.

FLX.ECAC.ER.PI 5.TG: Target not proposed by SESAR / available.

FLX.ECAC.ER PI 6: Airspace Segregated. Proportion of the airspace Designated Segregated.

FLX.ECAC.ER PI 6.TG: Target not proposed by SESAR / available.

FLX.ECAC.ER PI 7: Airspace utilisation. Utilisation of Airspace (Total Airspace Capacity, Available, requested, allocated, used).

FLX.ECAC.ER PI 7.TG: Target not proposed by SESAR / available.

5.3 Local Performance Indicators

5.3.1 Local Performance Indicators for Airports

5.3.1.1 Proposed Local PIs for Airport Capacity

The following capacity indicators are proposed. Some of these indicators aim to give measurements on **Capacity Provision** (provide network capacity for accommodating demand with expected QoS) and **Efficient Use of Capacity** (optimize use of capacity) based on throughputs and delays. These PIs are defined both for nominal and non-nominal conditions "i.e. IMC conditions (low visibility), weather constraints" at the airport. A specific subsection for the assessment of the temporary loss of capacity is also included:

Capacity Provision (VMC/IMC conditions):

CAP.LOCAL.APT.PI 1: Airport Capacity (VMC) and CAP.LOCAL.APT.PI 2: Airport Capacity (IMC): Maximum achievable mvts/hr:

- TARGET:

- o 60 mvts/hr in VMC (and 48 mvts/hr in IMC) for airport with a single runway (also airports with converging runways);
- o 90 mvts/hr in VMC (and 72 mvts/hr in IMC) for airport with parallel but dependent runways;
- o 120 mvts/hr in VMC (and 96 mvts/hr in IMC) for airport with parallel and independent runways;
- o For complex airports (with 3 or more runways), no generic targets are defined. These airports should be looked at individually.

CAP.LOCAL.APT.PI 3: Total Throughput (VMC) and CAP.LOCAL.APT.PI 4: Total Throughput (IMC): Total number of operations (departures + arrivals) along the day;

CAP.LOCAL.APT.PI 5: Maximum Throughput (VMC) and CAP.LOCAL.APT.PI 6: Maximum Throughput (IMC): Maximum number of operations per hour (departures + arrivals) along the day;

CAP.LOCAL.APT.PI 7: Mean Throughput (VMC) and CAP.LOCAL.APT.PI 8: Mean Throughput (IMC): Mean number of operations (departures + arrivals) between 07:00 and 22:00;

CAP.LOCAL.APT.PI 9: Arrival Delays (VMC) and CAP.LOCAL.APT.PI 10: Arrival Delays (IMC): Due to two possible reasons (this indicator is considered as a Predictability Indicator):

- Arrival Ground Delay: that would include taxi, apron and gate delays;
- Arrival Airspace Delay: for arrivals due to airport capacity restrictions.

  This indicator will be provided as the total arrival delay along the day, % of flights with arrival delay more than 1 minute, 2 minutes, 3 minutes,…. and average delays for delayed arrivals.

CAP.LOCAL.APT.PI 11: Departure Delays (VMC) and CAP.LOCAL.APT.PI 12: Departure Delays (IMC): Due to two possible reasons (this indicator is considered as an Efficiency Indicator):

- Departure Ground Delay: that would include taxi, apron and gate delays and runway delays;
- Dependency with arrival/departure flows (mix-mode or dependency between runways).

  This indicator will be provided as the total departure delay along the day, % of flights with arrival delay more than 1 minute, 2 minutes, 3 minutes,…. and average delays for delayed departures.

CAP.LOCAL.APT.PI 13: Total delays (VMC) and CAP.LOCAL.APT.PI 14: Total Delays (IMC): Addition of Arrival Delays and Departure delays.

Efficient Use of Capacity (VMC/IMC conditions):

CAP.LOCAL.APT.PI 15: Resource Utilization (VMC) and CAP.LOCAL.APT.PI 16: Resource Utilization (IMC): Resource utilization will be defined as the ratio between the maximum airport throughput along the day and the airport capacity. This indicator indicates the utilization of capacity. Values far from “one” will indicate that the studied airport has spare capacity. Values close to “one” will indicate the airport is saturated in at least the maximum value of throughput is presented;

CAP.LOCAL.APT.PI 17: Range Resource Utilization (VMC) and CAP.LOCAL.APT.PI 18: Range Resource Utilization (IMC): Range resource utilization will be defined as the ratio between the mean airport throughput along the day and the airport capacity. This indicator indicates the utilization distribution of capacity along the hours with high demand. Values far from “one” will indicate that the studied airport has spare capacity between 07:00 and 22:00.

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Values close to "one" will indicate that the airport is close to saturation between 07:00 and 22:00;

CAP.LOCAL.APT.PI 19: Median of the Resource Utilization (VMC) and CAP.LOCAL.APT.PI 20: Median of the Resource Utilization (IMC): Median of the resource utilization and range resource utilization of the airports at the ECAC Area. Median is better than mean because utilization distribution across the network is skewed (a few over-utilized nodes and a lot of under-utilised nodes).

Capacity gap between VMC and IMC conditions:

CAP.LOCAL.APT.PI 21: Difference between Airport Capacity (VMC) and Airport Capacity (IMC): Difference between Airport Capacity in VMC and IMC conditions:

- TARGET: reduce the gap so the airport capacity in IMC is not lower than 20% of airport capacity in VMC;

CAP.LOCAL.APT.PI 22: Ratio between Maximum Throughput (IMC) and Maximum Throughput (VMC): Ratio between the maximum number of operations per hour (departures + arrivals) along the day in IMC and VMC conditions.

- Values far from "one" will indicate that there is a significant gap in capacity between VMC and IMC conditions. Values close to "one" will indicate that there is no loss of capacity at the airport even when there are bad weather conditions "-i.e. low visibility conditions";

CAP.LOCAL.APT.PI 23: Difference between Mean Throughput (VMC) and Mean Throughput (IMC): Difference between Mean number of operations (departures + arrivals) between 07:00 and 22:00;

CAP.LOCAL.APT.PI 24: Difference between Total delays (VMC) – Total Delays (IMC): Difference between Addition of Arrival Delays and Departure Delays.

- This indicator will be provided as the difference of total delay along the day in VMC and IMC conditions, difference in the percentage of flights with delay bigger than 1 minute, 2 minutes, 3 minutes or more in VMC and IMC conditions and the difference in average total delay for delayed operations in VMC and IMC conditions.

5.3.1.2 Proposed PIs for Airport Efficiency

The following efficiency indicators are proposed (Arrival Delays are moved to Predictability as is indicated in last final release of SESAR T2.1.2 [19]). As it was mentioned in the previous section, these PIs are defined both for nominal and non-nominal conditions "-i.e. IMC conditions (low visibility), weather constraints" at the airport. A specific subsection for the assessment of the temporary loss of capacity is also included:

EFF.LOCAL.APT.PI 1: Departure Delays (VMC) and EFF.LOCAL.APT.PI 2: Departure Delays (IMC): Due to two possible reasons:

- Departure Ground Delay: that would include taxi, apron and gate delays and runway delays;
- Dependency with arrival/departure flows (mix-mode or dependency between runways):
    - % of departing flights delayed more than 1 minute, 2 minutes, 3 minutes or more;
    - The average departure delay of delayed flights.

EFF.LOCAL.APT.PI 3: Flight duration extension (VMC) and EFF.LOCAL.APT.PI 4: Flight duration extension (IMC):

- Percentage of flights with additional flight duration of more than 1 minute, 2 minutes, 3 minutes or more;

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- Average deviation time of flights with additional flight duration of more than 1 minute, 2 minutes, 3 minutes or more.

EFF.LOCAL.APT.PI 5: Difference between Departure delays (VMC) – Departure Delays (IMC):

- This indicator will be provided as the difference of departure delay along the day in VMC and IMC conditions, difference in the percentage of flights with departure delay bigger than 1 minute, 2 minutes, 3 minutes or more in VMC and IMC conditions and the difference in average departure delay for delayed departures in VMC and IMC conditions.

5.3.1.3 Proposed Local PIs for Airport Predictability

The following predictability indicators are proposed (both for nominal and non nominal conditions):

PRED.LOCAL.APT.PI 1: Arrival Delays/Arrival Punctuality (VMC) and PRED.LOCAL.APT.PI 2: Arrival Delays/Arrival Punctuality (IMC): Due to two possible reasons:

- Arrival Ground Delay: that would include taxi, apron and gate delays;
- Arrival Airspace Delay: for arrivals due to airport capacity restrictions.

  This indicator will be provided as the total arrival delay along the day, % of flights with arrival delay more than 1 minute, 2 minutes, 3 minutes or more and average delays for delayed arrivals.

PRED.LOCAL.APT.PI 3: Difference between Arrival delays (VMC) – Arrival Delays (IMC):

- This indicator will be provided as the difference of arrival delay along the day in VMC and IMC conditions, difference in the percentage of flights with arrival delay bigger than 1 minute, 2 minutes, 3 minutes or more in VMC and IMC conditions and the difference in average arrival delay for delayed departures in VMC and IMC conditions.

PRED.LOCAL.APT.PI 4: Temporal variation (VMC) and PRED.LOCAL.APT.PI5.Temporal variation (IMC): Coefficient of variation (standard deviation divided by mean) of gate-to-gate time differences between actual and last agreed values milestone times. The deviation is defined as the temporal difference between the milestones of the Actual 4D Trajectory and the agreed Business Trajectory.

PRED.LOCAL.APT.PI 6: Knock-on effect (rotation timeliness) (VMC) and PRED.LOCAL.APT.PI 7: Knock-on effect (rotation timeliness) (IMC): The performance indicators are related to:

- Reactionary delay;
- Number of cancelled flights.

5.3.1.4 Proposed Performance Indicators for Airport Flexibility

The indicators provided by T 2.1.2 [19] are related to the medium/short term more than to the execution phase at the airport. The following flexibility indicators are proposed:

FLX.LOCAL.APT.PI 1: Percentage of non-scheduled delayed flights at the airport: The airport tries to accommodate the non-schedule flights (flexible access on demand). It is the percentage of non-scheduled flights delayed more than 1minute, 2 minutes, 3 minutes….

FLX.LOCAL.APT.PI 2: Average delay of non-scheduled delayed flights: (minutes/delayed aircraft).

FLX.LOCAL.APT.PI 3: Percentage of delayed flights due to a Business trajectory update: Measurement of the airport flexibility to accommodate flights that have updated their Business

Trajectory. It is the percentage of flights with a business trajectory update delayed more than 1 minute, 2 minutes, 3 minutes, or more.

FLX.LOCAL.APT.PI 4: Average delay of delayed flights due to a Business trajectory update at the airport: (minutes/delayed aircraft).

FLX.LOCAL.APT.PI 5: Percentage of VFR-IFR change requests accommodated without penalties.

5.3.1.5 Proposed PIs for Airport Environmental Sustainability

ENV.LOCAL.APT.PI 1: Amount of CO_2 emitted below 3000ft per flight movement (average).

ENV.LOCAL.APT.PI 2: Amount of NO_x emitted below 3000ft per flight movement (average).

ENV.LOCAL.APT.PI 3: Amount of SOX emitted below 3000ft per flight movement (average).

ENV.LOCAL.APT.PI 4: Amount of SO_x emitted below 3000ft per flight movement (average).

ENV.LOCAL.APT.PI 5: Amount of CO emitted below 3000ft per flight movement (average).

ENV.LOCAL.APT.PI 6: Amount of HC emitted below 3000ft per flight movement (average).

ENV.LOCAL.APT.PI 7: Amount of PM_{10} emitted below 3000ft per flight movement (average).

ENV.LOCAL.APT.PI 8: Amount of $PM_{2.5}$ emitted below 3000ft per flight movement (average).

ENV.LOCAL.APT.PI 9: Surface areas where those pollutants exceed reglementary limits (concentration maps on annual average).

ENV.LOCAL.APT.PI 10: Number of Population inside those surface areas (population maps frozen at Baseline year to exclusively capture aviation influence).

ENV.LOCAL.APT.PI 11: Sum of Surface areas with Noise Level:

- Lden > 55dB day;
- Lnight > 50dB night.

ENV.LOCAL.APT.PI 11.TG: Reduction by 10% of the sum of surface areas with Noise Level.

ENV.LOCAL.APT.PI 12: Total Number of Population exposed to Noise Level:

- Lden > 55dB day;
- Lnight > 50dB night.

ENV.LOCAL.APT.PI 12.TG: Reduction by 10% of the total number of population exposed to Noise Level.

5.3.1.6 Proposed PIs for Airport Safety

The following predictability indicators are proposed (both for nominal and non nominal conditions):

SAF.LOCAL.APT.PI 1: Ground Conflicts (VMC) Number of times an ATC tactical intervention is needed in order to avoid a potential conflict (loss of minimum separation) on ground (VMC).

SAF.LOCAL.APT.PI 2: Ground Conflicts (IMC) Number of times an ATC tactical intervention is needed in order to avoid a potential conflict (loss of minimum separation) on ground (IMC). A conflict on ground is considered when an ATC intervention is needed to manage an intersection in the taxiway system or the usage of a bi-directional taxiway.

5.3.2 Local Performance Indicators for TMA

In this section, PIs relevant for TMA experiments are described. PIs with no code are not presentable as a value (map, diagram), but are still valuable.

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A set of indicator results is linked to a scenario which has a *geographic area* and duration.

The **duration** could last 1 hour in real time simulation, 15 hours in fast time simulation, or even 1 year in a more general assessment method.

The **geographic area**, where all indicators will be evaluated or computed, should as much as possible start before holdings and Initial Approach Fixes, finish at the intercept point of the glide path + 2 Nm, and exclude transit aircrafts. The geographic area should start for departure after aircraft take off, for example at 800ft. In the capacity section, the geographic area can be replaced by the most penalising sector. This geographic area should be the same for all other metrics.

5.3.2.1 Proposed Local PIs for TMA Capacity

CAP.LOCAL.TMA.PI 1: Sector capacity (Nb aircraft/h). Maximum number of aircraft that can exit the geographic area or the most penalising TMA sector in one hour. It must be measured when the system is in high traffic conditions (at the limit of what a controller can deal without reducing safety*)* for a whole hour. It can be based on the maximum task load the tactical controller can deal with in this period of time.

CAP.LOCAL.TMA.PI 2: Maximum simultaneous number (Nb aircraft). maximum simultaneous aircraft being controlled in the TMA.

CAP.LOCAL.TMA.PI 3: Total delays (min): Sum of delays, due to the TMA, for arrivals and for departures. The delay for arrivals is the difference between the planed arrival time and the actual arrival time. The delay for departures is given while it is on the ground.

CAP.LOCAL.TMA.PI 4: Total period throughput (Nb aircraft). Total number of aircraft controlled in the TMA during the 6h00-22h00 period.

CAP.LOCAL.TMA.PI 5: Maximum measured throughput (Nb aircraft/h). It is the maximum number of aircraft that actually exited the geographic area, or the most penalising TMA sector per hour with the considered traffic demand. It can be lower than the sector capacity, but can be equal to it when the system is fully loaded. This maximum measured throughput might be computed as the average of the maximum measured throughput for different controllers and traffic samples.

CAP.LOCAL.TMA.PI 6: Sector 10 min capacities (Nb aircraft). Maximum number of aircraft that can exit the TMA sector during a 10 minutes period. The measurement should be based on sector boundaries, rather that radio, in order to reduce grouping effects.

CAP.LOCAL.TMA.PI 7: Throughput (Nb/10min): Number of controlled aircraft per 10 minutes blocks in the TMA, during the day [for example 6 values for 1 hour of data].

CAP.LOCAL.TMA.PI 8: Clearances (Nb/10min): Number of headings, speed clearances, climb/descent, clearances measured in 10 minutes blocks [for example 6 values for 1 hour of data for each type of clearance].

CAP.LOCAL.TMA.PI 9: R/T contacts (Nb/10min): Number of R/T contacts per aircraft in 10 minutes blocks [for example 6 values for 1 hour of data].

CAP.LOCAL.TMA.PI 10: R/T contacts (sec/a/c): Average duration of R/T contacts per aircraft.

Mean throughput can easily be derived from *total number. Average delay* due to the TMA per aircraft can be computed from *total delays*. Note that delays are mainly intended for Efficiency.

5.3.2.2 Proposed Local PIs for TMA Environmental Sustainability

ENV.LOCAL.TMA.PI 1: Amount of CO_2 emitted below TMA ceiling per flight movement (average).

ENV.LOCAL.TMA.PI 2: Amount of NO_x emitted below TMA ceiling per flight movement (average).

ENV.LOCAL.TMA.PI 3: Amount of SOX emitted below TMA ceiling per flight movement (average).

ENV.LOCAL.TMA.PI 4: Amount of SO_x emitted below TMA ceiling per light movement (average).

ENV.LOCAL.TMA.PI 5: Amount of CO emitted below TMA ceiling per flight movement (average).

ENV.LOCAL.TMA.PI 6: Amount of HC emitted below TMA ceiling per flight movement (average).

ENV.LOCAL.TMA.PI 7: Amount of PM_{10} emitted below TMA ceiling per flight movement (average).

ENV.LOCAL.TMA.PI 8: Amount of $PM_{2.5}$ emitted below TMA ceiling per flight movement (average).

ENV.LOCAL.TMA.PI 9: Sum of Surface areas with Noise Level:

- Lden > 55dB day;
- Lnight > 50dB night.

ENV.LOCAL.TMA.PI 9.TG: Reduction by 10% of the sum of surface areas with Noise Level.

ENV.LOCAL.TMA.PI 10: Total Number of Population exposed to Noise Level:

- Lden > 55dB day;
- Lnight > 50dB night.

ENV.ECAC.PI 10.TG: Reduction by 10% of the total number of population exposed to Noise Level.

5.3.2.3 Proposed Local PIs for TMA Safety

SAF.LOCAL.TMA.PI 1: Conflict number (no unit) in the TMA. A conflict here means a potential separation loss. It is approximated as a separation of less than 2,5NM and 800ft that would occur 2 minutes ahead from the moment of observation, if the two aircrafts were maintaining their speed vector. This PI requires realistic tracks, and may therefore not be “easy” to evaluate.

SAF.LOCAL.TMA.PI 2: Number of separation losses in the TMA (no unit). Number of times a pair of aircraft goes below 3NM horizontal and 1000ft vertically. If *conflicts number* can not be evaluated, then this PI will do.

SAF.LOCAL.TMA.PI 3: Total overload duration (min). Times the controller is saturated with different severities and therefore, there are risky situations and then safety precursors. It is computed by analysing controller taskload during the day, and counting the cumulated time spent with taskload over a saturation limit. The saturation limit is subjective; it could be 70% of the maximum taskload.

SAF.LOCAL.TMA.PI 4: Total underload duration (min); Times the controller has quite nothing to do and therefore, there are risky situations and then safety precursors. It is computed by analysing controller taskload during the day, and counting the cumulated time spent with taskload under a minimal activity limit. The saturation limit is subjective; it could be 15% of the maximum taskload:

- Locations of the conflicts. Density maps could be produced based on this PI;
- Locations of the separation losses. Density maps could be produced based on this PI.

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5.3.2.4 Proposed Local PIs for TMA Efficiency

EFF.LOCAL.TMA.PI 1: Total flight duration **(**min). Sum of the flight durations in the scenario. Times during which aircraft are not in the geographic area are not considered. Time during which aircraft are flying before the beginning of the scenario are not considered too.

EFF.LOCAL.TMA.PI 2: Optimal total flight duration (min). Sum of the "best controlled" flight durations. The "best controlled" flight duration is the one the aircraft would have if it were alone in the TMA, following applicable procedures, from the first point of the geographic area to the last point of the geographic area of the TMA. It can be computed by taking into account aircraft performances. (See the beginning of the TMA section for precisions on the geographic area).

EFF.LOCAL.TMA.PI 3: Total Fuel consumption (kg): Fuel consumption in the geographic area. If it is not computable, then fuel consumption can be replaced by the flown distance (Nm).

EFF.LOCAL.TMA.PI 4: Optimal total fuel consumption (kg). Sum of the "best controlled" fuel consumptions. The "best controlled" fuel consumption of an aircraft is its fuel consumption that would be used to travel in the geographic area if it was alone, with no other traffic to disturb its trajectory. If not computable, it can be replaced by *total effective distance* in the "general performance indicators" section.

EFF.LOCAL.TMA.PI 5: Number of delays (Nb aircraft): Number of aircraft delayed by more that 3 minutes (a delay is the difference between expected time and actual time). Delay information can be found using flight plan data.

EFF.LOCAL.TMA.PI 6: Total delays (min): Sum of delays due to the TMA, for arrivals and for departures:

- List of delays per aircraft (min, one value per aircraft). This data will enable the evaluation of several PIs such as the percentage of aircraft delayed for more than 3 minutes, and PIs like *Total delays*, due to the TMA, for arrivals and for departures, or *average delay* due to the TMA per aircraft, evaluated for arrivals and for departures;
- List of flight durations per aircraft (min, one value per aircraft). This data could be used for the same reasons as for the delay list;
- List of fuel consumption per aircraft (kg, one value per aircraft). This data could be used for the same reasons as for the delay list;
- List of flown distances per aircraft (Nm, one value per aircraft). This data could be used for the same reasons as for the delay list.

5.3.2.5 Proposed Local PIs for TMA Flexibility

FLX.LOCAL.TMA.PI 1: RBT change success (%). Percentage of Business Trajectory that requested a 4D Trajectory change and either could not get it or got an *additional delay* of more than 3 minutes as a consequence, over the number of Business Trajectory that did the request. The *additional delay* is the difference between the time the aircraft actually flew in the geographic area and the time it would have flown if it did not make the request. The amount of incurred *additional delay* has an influence on efficiency indicators.

FLX.LOCAL.TMA.PI 2: VFR-IFR change success (%). Percentage of the VFR-IFR change requests accommodated without penalties.

FLX.LOCAL.TMA.PI 3: Proportion of Airspace Designated Segregated (%). Provides a yearly indication of airspace designated as segregated as a percentage of the nations total airspace. It is the sum of surfaces of segregated areas (in the geographical area of the scenario) multiplied by the duration of the segregation in hours and by the number of flight levels used, over the surface of the geographical area of the scenario multiplied by 24h and by 400, the whole multiplied by 100.

FLX.LOCAL.TMA.PI 4: Adherence to optimum Airspace Dimension (ratio). Gives a proportional measurement of how frequently military training has taken place within airspace areas that conform to the optimum airspace dimension (ratio of Allocated Airspace over Optimum Airspace Dimensions).

FLX.LOCAL.TMA.PI 5: Utilization of Airspace (ratio). Gives a measurement for segregated areas of time actually used for military flying training compared to the total time available for military training (Total Airspace Capacity available/requested/allocated/used).

FLX.LOCAL.TMA.PI 6: Efficient Booking Procedure (ratio). Gives an indication of actual airspace usage by military users compared with that booked by planners thus providing a measure of the degree of over- or under-booking of airspace by military planners (ratio of Time Used over Time Requested).

FLX.LOCAL.TMA.PI 7: Training in Non-Segregated Airspace (ratio). Measures how often military airspace users train in airspace not specifically designed for military training (ratio of Time Spent Training in Non-Segregated Areas over Total Training Time).

FLX.LOCAL.TMA.PI 8: Release of Airspace (ratio). Reports on the proportion of flexible use airspace military allocated but not used that was released for civil use on a time basis (ratio of Time given back before Scheduled Start over Time Cancelled).

5.3.2.6 Proposed Local PIs for TMA Predictability

PRE.LOCAL.TMA.PI 1: Unpredictable Deviation (min). *Unpredictable deviation* depends on how airspace users estimate flight times. As we may not have user estimates, we suppose here that they use the origin/destination parameter (the procedure in TMA), and the type of the aircraft. This is the rational for the *procedure deviation*. This PI enables to take into considerations procedures with different durations, and aircraft with different speeds and it still make the predictability computation valid.

- The *best controlled flight duration* is the one the aircraft would have if it were alone in the TMA, and still following applicable procedures. This is the duration to go from the first point the aircraft has in the geographic area (e.g. an Initial Approach Fix) to the last point the aircraft has in the geographic area (e.g the glide path + 2 Nm). Computing this time can be done with data analysis or with performance data using aircraft type and weight;
- A *deviation for an aircraft* is the difference between its actual flight duration and its *best controlled flight duration* (absolute value);
- A *procedure deviation* is for a specified TMA procedure the average deviations of flights that follow the procedure. This is the estimation an aircraft can make of the deviation it will encounter, knowing the procedure it will follow;
- The *unpredictable deviation* is the sum of absolute values of (*deviation – procedure deviation*), for all aircraft. If a procedure gives 60 seconds of deviation to all aircraft, it will be very predictable (*procedure deviation* = 60s, sum (deviation – procedure deviation) = sum (60 – 60) = 0, *unpredictable deviation* of procedure = 0);
- The computation is still valid if *best controlled duration* is replaced by the *initial flight plan duration*, the duration of the initial flight plan in the geographic area. What is important is to have a value that can be determined before the day the aircraft takes off. Using AMAN estimates is not appropriate, because this is an interactive value that takes into account other traffic, and which can not be set before the day of operation. For the same reason, the actual flight plan is not usable.

PRE.LOCAL.TMA.PI 2: Flight time deviation (no unit). Flight time standard deviation divided by mean flight time. This PI does not capture the fact that sub-groups of trajectories can have regular flight times internally, while their average flight time is different (two different procedures in TMA for example). It also does not capture the fact that aircrafts of different category have different speeds. Those two points could make *flight time deviation* big, while flight times are actually very predictable.

5.3.3 Local Performance Indicators for En-route

5.3.3.1 Proposed Local PIs for En-route Capacity

CAP.LOCAL.ER.PI 1: Total daily throughput. Total number of aircraft controlled in the En-route airspace volume during the day.

CAP.LOCAL.ER.PI 2: Maximum hourly throughput. Maximum number of controlled aircraft per hour in the airspace volume.

Hourly throughput: number of controlled aircraft per hour (sliding window) in the En-route airspace volume during the day. It is generally obtained through a sliding window over the day (generally 24 values).

CAP.LOCAL.ER.PI 3: Maximum 10 min throughput. Maximum throughput in 10 minutes block.

CAP.LOCAL.ER.PI 4: Maximum aircraft frequency. Maximum number of aircraft on frequency: maximum number of simultaneous aircraft under the control of an ATCo in the airspace volume per hour and in 10 minute blocks.

Based on estimation of task demand on the controller:

CAP.LOCAL.ER.PI 5: Estimated Airspace Volume Capacity. The estimated capacity is the maximum number of aircraft that can enter an airspace volume in one hour, based on the maximum task demand the tactical controller can deal with in this period of time (threshold).

CAP.LOCAL.ER.PI 6: Estimated Overall System Capacity**.** Maximum number of flights per hour in the ECAC Area taking into account traffic flows and airspace capacity restrictions.

CAP.LOCAL.ER.PI 7: Resource Efficiency (optimize use of network resources) Airspace Volume task demand Scattering. Scattering between task demand per airspace volume and the threshold saturation. This is an indicator of En-route airspace volume capacity utilization.

CAP.LOCAL.ER.PI 8: Aircraft count per sector. A measure of the number of aircraft per sector.

CAP.LOCAL.ER.PI 9: Aircraft density. A normalised measure of the aircraft density per sector.

Frequency of clearances:

CAP.LOCAL.ER.PI 10: Speed clearances.

CAP.LOCAL.ER.PI 11: Heading clearances.

CAP.LOCAL.ER.PI 12: Altitude clearances.

CAP.LOCAL.ER.PI 13: Number of directs.

5.3.3.2 Proposed Local PIs for En-route Efficiency

EFF.LOCAL.ER.PI 1: Actual Flight Time. Actual aircraft flight time taking into account the restrictions in the system.

EFF.LOCAL.ER.PI 2: Optimum Flight Time. Flight time with no constraints (ideal flight time as defined in SESAR 2.1.2 associated to the Initial SBT).

EFF.LOCAL.ER.PI 3: Airspace Volume Delay (min). Total Delay in the airspace volume taking into account traffic flows and airspace volume capacity restrictions.

EFF.LOCAL.ER.PI 4: % of flights delayed more than 3 minutes. Percentage of flights with a delay bigger than 3 minutes in the En-route airspace volume.

EFF.LOCAL.ER.PI 5: Fuel Efficiency (kg). Defined as the difference between the actual fuel consumed in the airspace volume and the optimum fuel consumed in the airspace volume (no constraint).

EFF.LOCAL.ER.PI 6: Actual Flight Time. Actual aircraft flight time.

EFF.LOCAL.ER.PI 7: Efficiency of routing service. Comparison of actual routing to Initial shared business trajectory.

EFF.LOCAL.ER.PI 8: Duration Increase. This is the ratio: actual trajectory duration divided by optimum trajectory duration.

EFF.LOCAL.ER.PI 9: Lateral deviation. Mean lateral deviation between SBT route and actual flown route.

EFF.LOCAL.ER.PI 10: Vertical deviation. Mean vertical deviation between SBT route and actual flown route.

EFF.LOCAL.ER.PI 11: Number of flights able to fly the requested altitude. Number of flights whose max. Altitude equalled the requested altitude in their SBT.

5.3.3.3 Proposed Local PIs for En-route Predictability

PRED.LOCAL.ER.PI 1: Flight Time Deviation (min). For each flight, the difference between the actual flight duration and the optimum flight duration (no constraints).

PRED.LOCAL.ER.PI 2: Flight time Standard Deviation (no unit).

5.3.3.4 Proposed Local PIs for En-route Safety

They are defined as safety precursors (situations that could lead into a conflict).

SAF.LOCAL.ER.PI 1: Number of hours with excessive ATC task demand. Times the controller is saturated with different severities and therefore, there are risky situations and then safety precursors.

SAF.LOCAL.ER.PI 2: Number of hours with under loads of ATC task demand. Not only overload but also under load situations can cause safety critical situations according to relevant studies.

SAF.LOCAL.ER.PI 3: Number of ATC tactical interventions. Number of times an ATC tactical intervention is needed in order to avoid a potential conflict on air; Number of losses of minimum separation.

SAF.LOCAL.ER.PI 4: Geographical distribution of losses of minimum separation. The maps will provide information on the locations of the conflicts identifying critical areas (density of conflicts).

SAF.LOCAL.ER.PI 5: Conflict alerts. Number of STCA conflicts alerts that occurs during the simulation.

SAF.LOCAL.ER.PI 6: Separation between aircraft pair in conflict:

- Vertical;
- Horizontal.

SAF.LOCAL.ER.PI 7: Number of intersecting flight paths. This is the number of routes or airways that cross within the sector.

SAF.LOCAL.ER.PI 8: Number or resolutions:

- Number of lateral resolutions. Number of conflicts that have been solved using only lateral manoeuvres;

- Number of vertical resolutions. Number of conflicts that have been solved using only vertical manoeuvres.

SAF.LOCAL.ER.PI 9: Number of aircraft taken into account for a resolution. For each resolution, the number of aircraft that the one in charge of it had to take into account.

SAF.LOCAL.ER.PI 10: Resolution complexity. The number of manoeuvres required to solve a conflict.

SAF.LOCAL.ER.PI 11: Frequency of clearances:

- Speed clearances;
- Heading clearances;
- Altitude clearances.

5.3.3.5 Proposed Local PIs for En-route Environmental Sustainability

ENV.LOCAL.ER.PI 1: Amount of CO_2 emitted above 3000ft per flight movement (average);

ENV.LOCAL.ER.PI 2: Amount of NO_x emitted above 3000ft per flight movement (average);

ENV.LOCAL.ER.PI 3: Amount of SOX emitted above 3000ft per flight movement (average);

ENV.LOCAL.ER.PI 4: Amount of SO_x emitted above 3000ft per flight movement (average);

ENV.LOCAL.ER.PI 5: Amount of CO emitted above 3000ft per flight movement (average);

ENV.LOCAL.ER.PI 6: Amount of HC emitted above 3000ft per flight movement (average);

ENV.LOCAL.ER.PI 7: Amount of PM_{10} emitted above 3000ft per flight movement (average);

ENV.LOCAL.ER.PI 8: Amount of $PM_{2.5}$ emitted above 3000ft per flight movement (average).

5.3.3.6 Proposed Local PIs for En-route Flexibility

FLX.LOCAL.ER PI 1: Local change requests. Percentage of VFR-IFR change requests accommodated without penalties in the airspace volume.

FLX.LOCAL.ER.PI 2: RBT change success (%). Percentage of Business Trajectory that requested a 4D Trajectory change and either could not get it or got an *additional delay* of more than 3 minutes as a consequence, over the number of Business Trajectory that did the request. The *additional delay* is the difference between the time the aircraft actually flew in the geographic area and the time it would have flown if it did not make the request. The amount of incurred *additional delay* has an influence on efficiency indicators.

FLX.LOCAL.ER.PI 3: VFR-IFR change success (%). Percentage of the VFR-IFR change requests accommodated without penalties.

FLX.LOCAL.ER.PI 4: Proportion of Airspace Designated Segregated (%). Provides a yearly indication of airspace designated as segregated as a percentage of the nations total airspace. It is the sum of surfaces of segregated areas (in the geographical area of the scenario) multiplied by the duration of the segregation in hours and by the number of flight levels used, over the surface of the geographical area of the scenario multiplied by 24h and by 400, the whole multiplied by 100.

FLX.LOCAL.ER.PI 5 Adherence to optimum Airspace Dimension (ratio). Gives a proportional measurement of how frequently military training has taken place within airspace areas that conform to the optimum airspace dimension (ratio of Allocated Airspace over Optimum Airspace Dimensions).

FLX.LOCAL.ER.PI 6: Utilization of Airspace (ratio). Gives a measurement for segregated areas of time actually used for military flying training compared to the total time available for military training (Total Airspace Capacity available/requested/allocated/used).

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FLX.LOCAL.ER.PI 7: Efficient Booking Procedure (ratio). Gives an indication of actual airspace usage by military users compared with that booked by planners thus providing a measure of the degree of over- or under-booking of airspace by military planners (ratio of Time Used over Time Requested).

FLX.LOCAL.ER.PI 8: Training in Non-Segregated Airspace (ratio). Measures how often military airspace users train in airspace not specifically designed for military training (ratio of Time Spent Training in Non-Segregated Areas over Total Training Time).

FLX.LOCAL.ER.PI 9: Release of Airspace (ratio). Reports on the proportion of flexible use airspace military allocated but not used that was released for civil use on a time basis (ratio of Time given back before Scheduled Start over Time Cancelled).

6 CONCLUSIONS

The EP3 WP2.4.1 Performance Framework is key document as it provides a methodology for future assessment of the SESAR concept on an 2020 ECAC wide basis as no such model currently exists. To this end it explains how the validation measurement of different level of granularity and uncertainty will be aggregated and also provides common reference on "WHAT" to measure".

It is aligned with SESAR through the previous work from the SESAR definition phase. This alignment is strengthened by the continued participation of the SESAR team on the EP3 task.

The methodology is based on:

- An understanding of the elements that contribute and influence the performance (Influence Diagrams);
- An ECAC Model that represents the elements that are linked and the mechanism to combine their influences (Influence models);
- The definition of a catalogue of common Performance Indicators (PI) as references to ensure consistency and capture data about the influencing factors from exercises, expert group, current and past studies.

The EP3 WP 2.4.1 Performance Framework has further developed six of the SESAR's Key Performance Areas (KPAs) (Capacity, Efficiency, Flexibility, Predictability, Safety, Environment).

The influence diagrams developed in SESAR D3 [17], *Definition of the future ATM Target* and in D4 [15], *Selection of the "Best" Deployment Scenario* were used as a starting point to build the relationships among the different layers of Performance Indicators and Key Performance Areas. The EP3 influence diagrams were developed during 2008 and will be delivered early 2009. The EP3 improvement to the SESAR influence diagrams work includes a wider coverage of the KPA and the use of a decision support tool that ensures consistency between the influence diagrams and the model and allows diagrams to be presented at different levels of detail.

The EP3 WP 2.4.1 Performance Framework has defined different layers of performance indicators according to the performance areas. The catalogue of PIs is divided into three layers:

- ECAC wide;
- ECAC Airport, TMA, En-route;
- Local Performance Indicators for Airport, TMA and En-route.

The EP3 validation exercises are expected to use these Performance Indicators however new Performance Indicators could be included in the course of the project. In case where the exercises use metrics not in this catalogue, they are responsible for providing an integration process to feed the ECAC model. In this context, the template given in Annex IV might give some useful guidance to the Exercises in order to provide the correct data to the ECAC model developed within WP2.

The Performance Framework will contribute to the prerequisite to start the first round of the Performance Validation of the SESAR Operational Concept and will evolve along the progress of work of EP3, the SESAR definition phase and the SESAR development phase under the management of the SESAR Joint Undertaking (SJU).

7 REFERENCES AND APPLICABLE DOCUMENTS

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8 ANNEX I. COMPLIANCE TABLE WITH THE VALIDATION REQUIREMENTS

This annex shows the compliance of the present document with the requirements the Performance Framework from Ref. [26].

References	Validation Requirements	Compliance Justifications
VR-PF-1	The Performance Framework SHALL describes the KPA, KPI and Key Intermediate Metrics (KIM) which shall be used in EP3 to assess the ability of the SESAR Operational Concept to meet the 2020 performance targets.	See chapters 2.1 Key Performance Areas and their Targets and 5 Catalogue of Performance indicators.
VR-PF-2	The Performance Framework KPA, and KPI shall be derived directly from the KPA and Focus Areas identified in SESAR D2.	See chapters 2.1 Key Performance Areas and their Targets and 5 Catalogue of Performance indicators.
VR-PF-3	The Performance Framework SHALL cover all the operational segments considered for SESAR.	See chapters 0 Executive summary and 1.4 Background "The EP3 (EP3) objective is to deliver a first round of the validation of the SESAR Operational Concept. EP3 Performance Framework. SESAR are aligned through taking into account SESAR deliverables" and "The SESAR Operational Concept to be validated consists of a number of Performance Target and Operational Improvements. In order to support the exercises to identify the best metrics to assess their validation objectives, the link between the OI and PIs will be described in this framework." See also Annex II. Influence Diagram
VR-PF-4	The Performance Frame work shall identify and allocate target levels to KPA and KPI based on the SESAR target levels of D2.	See chapters 2.1 Key Performance Areas and their Targets and 5 Catalogue of Performance indicators.
VR-PF-5	The initial delivery of the Performance Framework SHALL already embody the structure necessary to support tracking of performance on the CAPACITY, EFFICIENCY, FLEXIBILITY, PREDICTABILITY KPA..	See chapters 2.1 Key Performance Areas and their Targets and 5 Catalogue of Performance indicators. In addition the naming convention of the catalogue.

References	Validation Requirements	Compliance Justifications
VR-PF-6	The Initial delivery of the Performance Framework SHALL include a catalogue of clearly defined Key Intermediate Metrics (KIM) which are considered appropriate to measure the performance of mechanisms contributing to the delivery of performance on the subject KPA & KPI. (This catalogue is to be considered as a starting point for an iterative (and traceable) refinement process to establish a stable Catalogue of Performance Measures for the SESAR concept).	See chapters 2.1 Key Performance Areas and their Targets and 5 Catalogue of Performance indicators. In addition the naming convention of the catalogue.
VR-PF-7	The initial delivery of the Performance Framework SHALL be extensible to support the SAFETY and ENVIRONMENTAL, KPA, their associated KPI and allocated target levels.	See chapters 2.1.2 Environmental Sustainability, 2.1.3 Safety, 2.1 Key Performance Areas and their Targets and 5 Catalogue of Performance indicators.

Table 8-1 Requirements relating to SESAR D2 performance framework and targets

9 ANNEX II. INFLUENCE DIAGRAM / MODEL

The EP3 Influence Diagrams (EP3 ID) were developed in a step-wise process. Initially a comprehensive set of independent influence diagrams was developed. Following discussions with EP3 partners these diagrams were integrated into one comprehensive influence diagram, which is given as a separate Annex to the present document in:

E3-WP2-D2.4.1-04a-TEC-V1.03-diagrams.doc.

The EP3 Influence Model (IM) has been developed using Analytica Professional (version 4.1) and the corresponding file is added as a separate Annex to the present document in:

E3-WP2-D2.4.1-04d-TEC-V3.00-ecac-wide-performance-model-and-input-data folder file MTV Influence Model - quantification v3.0.ANA.

The Episode 3 Influence Model study has not quantified all of the focus areas within the model. Because of time constraints and the limited information available from validation exercises, the study has selected a number of focus areas to quantify in order to show that the methodology used for influence modelling is valid. For these focus areas the model has been populated, to a considerable extent, by data based on expert judgement and Performance Review Report (PRR).

For the focus areas that have been quantified the data supporting the quantification is presented in an MS Excel data input file, which is given as a separate Annex to the present document in:

E3-WP2-D2.4.1-04d-TEC-V3.00-ecac-wide-performance-model-and-input-data folder file Input data required - MASTER.xls.

Finally, a user manual providing a description of the requirements for using the model, hardware and software requirements and high-level instructions for running the model has been developed and is also added as a separate Annex to the present document in:

E3-WP2-D2.4.1-04c-TEC-V0.07-influence-model-user-manual.doc.

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10 ANNEX III. LIST OF THE PERFORMANCE INDICATORS AND TRACEABILITY BETWEEN OI / OI STEPS AND ECAC PIS

10.1 LIST OF PERFORMANCE INDICATORS

This section shows an extract of the Capacity Performance Indicators spreadsheet that can be found in Ref [10] *Catalogue of PIs and Traceability OI Step vs ECAC PIs Annex to Performance Framework*.

Performance Indicator Identifier	Performance Indicator Short Name	Performance Indicator Description	Performance Indicator Target
ECAC PIs			
CAP.ECAC.PI 1	Annual number of IFR flights in Europe	Annual number of IFR flights that can be accommodated in Europe	2020, The European ATM system will need to be able to handle 70% more flights per year than in 2005. This corresponds to 16 million flights
CAP.ECAC.PI 2	Daily number of IFR flights in Europe	Daily number of IFR flights that can be accommodated in Europe	2020 target: 49,000 flights/day; 2020+ target:73,000 flights/day by the end of the design life of the concept
CAP.ECAC.PI 3	Hourly throughput overloads	Hourly throughput overloads, number of occurrences of capacity (hourly throughput) overloads by overload level per sector/airport/ point	To be determined
Airtport, TMA and En-RouteECAC PIs			
Airport			
CAP.ECAC.APT.PI 1	Annual number of IFR flights at Airport level	Annual number of IFR flights that can be accommodated at Airport level	To be determined
CAP.ECAC.APT.PI 2	Daily number of IFR flights at Airport level	Daily number of IFR flights that can be accommodated at Airport level between 0700 and 2200 hrs local time	To be determined
CAP.ECAC.APT.PI 3	Hourly capacity at Airport level	Number of IFR flights that can be accommodated at Airport level per hour	To be determined
TMA			
CAP.ECAC.TMA.PI 1	1h Capacity (Nb aircraft/hour)	Maximum number of aircraft that can exit the geographic area in one hour. It must be measured when the system is overloaded (or fully loaded, in high traffic conditions) for a whole hour	To be determined
CAP.ECAC.TMA.PI 2	Maximum simultaneous number of aircraft (Nb aircraft)	Maximum simultaneous aircraft being controlled in the TMA	To be determined
CAP.ECAC.TMA.PI 3	Total delays (minutes)	Sum of delays, due to the TMAs, for arrivals and for departures. The delay for arrivals is the difference between the planed arrival time and the actual arrival time. The delay for departures is given while it is on the ground	To be determined
CAP.ECAC.TMA.PI 4	Total period throughput (Nb aircraft)	Total number of aircraft controlled in the TMA during the scenario duration	To be determined
CAP.ECAC.TMA.PI 5	Maximum measured throughput (Nb aircraft/hour)	It is the maximum number of aircraft that actually exited the geographic area, per hour with the considered traffic demand. It is either lower that ECAC TMA capacity or equal to it when the system is fully loaded	To be determined
CAP.ECAC.TMA.PI 6	10 minutes capacity (Nb aircraft)	Maximum number of aircraft that can exit the geographic area during a 10 minutes period. The measurement should be based on sector boundaries, rather that radio, in order to reduce grouping effects	To be determined
En-Route			
CAP.ECAC.ER.PI 1	Annual flights accommodated	Annual number of IFR flights that can be accommodated at En Route level	To be determined
CAP.ECAC.ER.PI 2	Daily flights accommodated	Daily number of IFR flights that can be accommodated at En Route level	To be determined
CAP.ECAC.ER.PI 3	Hourly throughput overloads	Number of occurrences of capacity (hourly throughput) overloads by overload level per sector or airspace volume level	To be determined
Local Metrics			
Airport			
CAP.LOCAL.APT.PI 1	Airport Capacity (VMC)	Maximum achievable movements per hour	60 movements per hour in VMC for airport with a single runway (also airports with converging runways). 90 movements per hour in VMC for airport with parallel but dependent runways. 120 movements per hour in VMC for airport with parallel and independent runways. For complex airports (with 3 or more runways), no generic targets are defined. These airports should be looked at individually.

Table 10-1 Extract of the Capacity Performance Indicators

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10.2 TRACEABILITY BETWEEN OI STEPS AND ECAC PIS

The validation exercises held inside the EP3 project will validate the OIs that come from SESAR in order to validate the Concept of Operations. Each exercise will implement an OI step or a set of OI steps. This document is using version 1.3 of the list of OIs and OI Steps developed by SESAR WP 2.2.4 in the context of D4 [15]. For more information about the list of OI/OI Steps (see SESAR WP2.2.4 deliverable or the Excel file "EP3 2.4.1 Traceability - OI Step - PIs.xls") developed by EP3 WP2.4.1, *Performance Framework*, in which a list of OI/OI Steps has been inserted.

Initial sets of groups of PIs per OI were defined, and refined by the partners. The gathering of the PIs groups was based on proposed validation exercises for each OI. It was a decision of each partner to include or exclude a PI in a determined group.

A further refinement of the groups of PIs was done by clustering the PIs per OI step (See Ref [10] *EP3 WP241 Catalogue of PIs and Traceability OI Step vs ECAC PIs.xls)*.

Matrix Definition and Legend								
This matrix shows the impact that the Operational Improvements Steps (OI Steps left side of the matrix) developed in SESAR have on the Performance Indicators at ECAC Level (ECAC PIs upper side of the matrix) developed by the EP3 WP 2.4.1. Only the ECAC PIs which are related to the operational SESAR KPAs (Key Performance Areas) are shown.								
KPAs	(light cyan)	Capacity	(light blue)	Flexibility	(cyan)	Flexibility	(blue)	Predictability
(red)	The red colour means that the related OI Step has a **bad impact** in the associated ECAC PI							
(yellow)	The yellow colour means that the related OI Step has a **positive but low impact** on the ECAC PI							
(green)	The green colour means that the related OI Step has a **positive and high impact** on the ECAC PI							
(white)	The white colour means that the related OI Step has **no impact** in the associated ECAC PI							

Table 10-2 Matrix Definition and Legend (for OI steps and ECAC PIs)

OI Step Code	ECAC PIs																						
	CAP.ECAC.PI 1	CAP.ECAC.PI 2	CAP.ECAC.PI 3	EFF.ECAC.PI 1	EFF.ECAC.PI 2	EFF.ECAC.PI 3	EFF.ECAC.PI 4	EFF.ECAC.PI 5	EFF.ECAC.PI 6	FLX..ECAC.PI 1	FLX..ECAC.PI 2	FLX..ECAC.PI 3	FLX..ECAC.PI 4	FLX..ECAC.PI 5	FLX..ECAC.PI 6	FLX..ECAC.PI 7	FLX..ECAC.PI 8	PRED.ECAC.PI 1	PRED.ECAC.PI 2	PRED.ECAC.PI 3	PRED.ECAC.PI 4	PRED.ECAC.PI 5	PRED.ECAC.PI 6	PRED.ECAC.PI 7
DCB-0301																							
DCB-0302																							
IS-0101																							
IS-0102																							
IS-0201																							
IS-0401																							
IS-0402																							
IS-0202																							
IS-0203																							
IS-0204																							
IS-0701																							
IS-0702																							
IS-0703																							
IS-0704																							
IS-0705																							
IS-0706																							
IS-0707																							
IS-0708																							
IS-0709																							
IS-0710																							
IS-0301																							
IS-0302																							
IS-0303																							
IS-0305																							
IS-0406																							
IS-0407																							
IS-0501																							

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OI Step Code	ECAC PIs																						
	CAP.ECAC.PI 1	CAP.ECAC.PI 2	CAP.ECAC.PI 3	EFF.ECAC.PI 1	EFF.ECAC.PI 2	EFF.ECAC.PI 3	EFF.ECAC.PI 4	EFF.ECAC.PI 5	EFF.ECAC.PI 6	FLX..ECAC.PI 1	FLX..ECAC.PI 2	FLX..ECAC.PI 3	FLX..ECAC.PI 4	FLX..ECAC.PI 5	FLX..ECAC.PI 6	FLX..ECAC.PI 7	FLX..ECAC.PI 8	PRED.ECAC.PI 1	PRED.ECAC.PI 2	PRED.ECAC.PI 3	PRED.ECAC.PI 4	PRED.ECAC.PI 5	PRED.ECAC.PI 6	PRED.ECAC.PI 7
AOM-0101																							
AOM-0102																							
AOM-0103																							
AOM-0201																							
DCB-0203																							
AOM-0202																							
AOM-0203																							
AOM-0204																							
AOM-0205																							
AOM-0206																							
AOM-0208																							
AOM-0301																							
AOM-0302																							
AOM-0303																							
AOM-0304																							
AOM-0401																							
AOM-0402																							
AOM-0403																							
AOM-0501																							
AOM-0502																							
AOM-0503																							
AOM-0601																							
AOM-0602																							
AOM-0701																							
AOM-0702																							
AOM-0703																							
AOM-0704																							
AOM-0705																							

Issued by the Episode 3 consortium for the Episode 3 project co-funded by the European Commission and Episode 3 Consortium.

OI Step Code	ECAC PIs																							
	CAP.ECAC.PI 1	CAP.ECAC.PI 2	CAP.ECAC.PI 3	EFF.ECAC.PI 1	EFF.ECAC.PI 2	EFF.ECAC.PI 3	EFF.ECAC.PI 4	EFF.ECAC.PI 5	EFF.ECAC.PI 6	FLX..ECAC.PI 1	FLX..ECAC.PI 2	FLX..ECAC.PI 3	FLX..ECAC.PI 4	FLX..ECAC.PI 5	FLX..ECAC.PI 6	FLX..ECAC.PI 7	FLX..ECAC.PI 8	PRED.ECAC.PI 1	PRED.ECAC.PI 2	PRED.ECAC.PI 3	PRED.ECAC.PI 4	PRED.ECAC.PI 5	PRED.ECAC.PI 6	PRED.ECAC.PI 7
AOM-0801																								
AOM-0802																								
AOM-0803																								
AOM-0804																								
CM-0102																								
SDM-0201																								
SDM-0202																								
SDM-0203																								
DCB-0101																								
DCB-0102																								
DCB-0103																								
DCB-0201																								
AUO-0101																								
AUO-0102																								
AUO-0201																								
AUO-0203																								
AUO-0204																								
DCB-0204																								
DCB-0205																								
DCB-0206																								
DCB-0207																								
DCB-0208																								
DCB-0303																								
DCB-0305																								
SDM-0101																								
SDM-0102																								
SDM-0103																								
AUO-0301																								

OI Step Code	ECAC PIs																							
	CAP.ECAC.PI 1	CAP.ECAC.PI 2	CAP.ECAC.PI 3	EFF.ECAC.PI 1	EFF.ECAC.PI 2	EFF.ECAC.PI 3	EFF.ECAC.PI 4	EFF.ECAC.PI 5	EFF.ECAC.PI 6	FLX..ECAC.PI 1	FLX..ECAC.PI 2	FLX..ECAC.PI 3	FLX..ECAC.PI 4	FLX..ECAC.PI 5	FLX..ECAC.PI 6	FLX..ECAC.PI 7	FLX..ECAC.PI 8	PRED.ECAC.PI 1	PRED.ECAC.PI 2	PRED.ECAC.PI 3	PRED.ECAC.PI 4	PRED.ECAC.PI 5	PRED.ECAC.PI 6	PRED.ECAC.PI 7
AUO-0302																								
AUO-0303																								
AUO-0304																								
CM-0101																								
CM-0103																								
CM-0104																								
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CM-0402																								
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CM-0401																								
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CM-0404																								
CM-0405																								
CM-0406																								
TS-0102																								
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TS-0104																								
TS-0106																								
TS-0303																								
TS-0305																								
TS-0201																								
TS-0202																								
TS-0203																								
TS-0302																								

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OI Step Code	ECAC PIs																						
	CAP.ECAC.PI 1	CAP.ECAC.PI 2	CAP.ECAC.PI 3	EFF.ECAC.PI 1	EFF.ECAC.PI 2	EFF.ECAC.PI 3	EFF.ECAC.PI 4	EFF.ECAC.PI 5	EFF.ECAC.PI 6	FLX..ECAC.PI 1	FLX..ECAC.PI 2	FLX..ECAC.PI 3	FLX..ECAC.PI 4	FLX..ECAC.PI 5	FLX..ECAC.PI 6	FLX..ECAC.PI 7	FLX..ECAC.PI 8	PRED.ECAC.PI 1	PRED.ECAC.PI 2	PRED.ECAC.PI 3	PRED.ECAC.PI 4	PRED.ECAC.PI 5	PRED.ECAC.PI 6	PRED.ECAC.PI 7
TS-0306																							
TS-0301																							
TS-0304																							
CM-0501																							
CM-0601																							
CM-0602																							
CM-0603																							
CM-0604																							
AUO-0401																							
AUO-0402																							
AUO-0503																							
CM-0701																							
CM-0702																							
TS-0105																							
TS-0107																							
AUO-0504																							
CM-0704																							
CM-0801																							
CM-0802																							
CM-0803																							
CM-0804																							
CM-0805																							
CM-0806																							
CM-0807																							
AO-0101																							
AO-0102																							
AO-0103																							
AO-0104																							

OI Step Code	ECAC PIs																						
	CAP.ECAC.PI 1	CAP.ECAC.PI 2	CAP.ECAC.PI 3	EFF.ECAC.PI 1	EFF.ECAC.PI 2	EFF.ECAC.PI 3	EFF.ECAC.PI 4	EFF.ECAC.PI 5	EFF.ECAC.PI 6	FLX..ECAC.PI 1	FLX..ECAC.PI 2	FLX..ECAC.PI 3	FLX..ECAC.PI 4	FLX..ECAC.PI 5	FLX..ECAC.PI 6	FLX..ECAC.PI 7	FLX..ECAC.PI 8	PRED.ECAC.PI 1	PRED.ECAC.PI 2	PRED.ECAC.PI 3	PRED.ECAC.PI 4	PRED.ECAC.PI 5	PRED.ECAC.PI 6	PRED.ECAC.PI 7
AO-0201																							
AO-0202																							
AUO-0605																							
AO-0203																							
AO-0204																							
AO-0205																							
AO-0206																							
AO-0207																							
AUO-0602																							
AUO-0603																							
AUO-0604																							
AO-0501																							
AO-0601																							
AO-0602																							
AO-0603																							
DCB-0304																							
AO-0402																							
AO-0403																							
AUO-0701																							
AUO-0702																							
AUO-0703																							
AO-0301																							
AO-0302																							
AO-0303																							
AO-0304																							
AO-0305																							
AO-0502																							
AO-0503																							

OI Step Code	ECAC PIs																							
	CAP.ECAC.PI 1	CAP.ECAC.PI 2	CAP.ECAC.PI 3	EFF.ECAC.PI 1	EFF.ECAC.PI 2	EFF.ECAC.PI 3	EFF.ECAC.PI 4	EFF.ECAC.PI 5	EFF.ECAC.PI 6	FLX..ECAC.PI 1	FLX..ECAC.PI 2	FLX..ECAC.PI 3	FLX..ECAC.PI 4	FLX..ECAC.PI 5	FLX..ECAC.PI 6	FLX..ECAC.PI 7	FLX..ECAC.PI 8	PRED.ECAC.PI 1	PRED.ECAC.PI 2	PRED.ECAC.PI 3	PRED.ECAC.PI 4	PRED.ECAC.PI 5	PRED.ECAC.PI 6	PRED.ECAC.PI 7
AO-0504																								
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AUO-0802																								
AUO-0803																								

Table 10-3 OIs step code vs. ECAC PIs

11 ANNEX IV. VALIDATION ACTIVITIES AND OI STEP ADDRESSED

This annex shows a possible template to be delivered to the EP3 validation exercises, in order to feed the ECAC Model developed by WP 2.4.1 during 2008.

Validation Scenario	Summary / Purpose	Hypothesis	Validation Exercise Objectives	SESAR OI/OI Steps addressed	Performance Indicators	Measurement Uncertainty / Confidence range	Performance Indicator Value
Scenario 1							
Scenario 2							
Scenario …							
Scenario [n]							

Table 11-1 Example of Template – EP3 validation exercises

END OF DOCUMENT