EPISODE 3

Single European Sky Implementation support through Validation

Sixth Framework Programme

Document information	
Programme	Sixth framework programme Priority 1.4 Aeronautics and Space
Project title	Episode 3
Project N°	037106
Project Coordinator	EUROCONTROL Experimental Centre
Deliverable Name°	EP3 Performance Framework cycle 1
Deliverable ID	D2.0-03
Version	2.2
Version date	21 April 2008
Status	Accepted
Classification	Public
Filename	E3-WP2-D2.0-03-V2.2-WP2.4.1 Performance Framework.doc
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DOCUMENT CONTROL

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European Commission	EC	Katarzyna Gryc	2.2	

Version history

Version	Date	Status	Author(s)	Justification - Could be a reference to a review form or a comment sheet
0.1	26/10/2007	DRAFT	L. Jimenez, E. Casado, R. Garcia	Initial Draft
1.0	5/12/2007	DRAFT	AENA, ATMB, CAST, DFS, DSNA, ERC, ISDEFE, NATS.	First Draft distributed to the project for comments
1.7	16/01/2008	DRAFT	AENA, ATMB, CAST, DFS, DSNA, ERC, ISDEFE, NATS.	Second Draft distributed to the project for comments
2.0	31/01/2008	Reviewed	AENA, ATMB, CAST, DFS, DSNA, ERC, ISDEFE, NATS.	Deliverable to Work Package leader, validation Cell and Quality manager
2.0	31/01/2008	Approved	AENA, ATMB, CAST, DFS, DSNA, ERC, ISDEFE, NATS.	Deliverable to Project Coordinator and first delivery to the European Commission
2.1	14/03/2008	Approved	AENA, ATMB, CAST, DFS, DSNA, ERC, ISDEFE, NATS.	Integration of the comments from the European Commission.
2.2	10/04/2008	Accepted	AENA, ATMB, CAST, DFS, DSNA, ERC, ISDEFE, NATS.	EC Acceptance with reservations: environmental focus area and presentation of the catalogue of performance indicators will be improved in Sept. 2008

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1 EXECUTIVE SUMMARY

The Episode 3 (EP3) objective is to deliver a first validation of the SESAR Operational Concept. The alignment of the EP3 Performance Framework (PF) and SESAR is based on previous work from SESAR as its deliverables became available (see below). There have been informal links between both programmes.

The EP3 Performance Framework is a key document for the project as it defines the catalogue of metrics to be used as common references. It defines "WHAT" will be measured by the validation exercises and develop a methodology that will allow to obtain a 2020 ECAC performance of the SESAR 2020 Operational Improvements.

To develop the Performance Framework, EP3 WP 2.4.1 has used D2 of SESAR, *Air Transport Framework [2]* that present the full set of SESAR's eleven Key Performance Areas – *the Performance Target [2]* as its main source of information. The D2 document characterises the SESAR performance framework that should be used to define, measure, and manage the performance of the future ATM System, including some performance targets.

SESAR has since revised the targets and delivered a new version of the SESAR Performance objectives and Targets document. This has also been taken into account during the development of the Performance Indicators (PI).

The SESAR Performance Framework described in D2 is aligned with the guidance material contained in the *ICAO Global Performance Manual (GPM) [7].* The ICAO GPM guidance material is equally relevant to the future development of the EP3 Performance Framework.

This document introduces the framework needed to build the ECAC model that will address six of the SESAR's Key Performance Areas (KPAs) being assessed in the EP3 project, these KPAs will be further developed in this document.

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

The influence diagrams developed in SESAR D3 deliverable*, Definition of the future ATM Target and in D4 deliverable, Selection of the "Best" Deployment Scenario* were used to build the relationships among the different layers of Performance Indicators and Key Performance Areas.

The EP3 WP 2.4.1 provides the Performance Framework with the performance indicators their related targets and the influence diagrams related to the KPAs Capacity, Efficiency, Flexibility and Predictability. These influence diagrams will be further developed during 2008. The PIs, targets and influence diagrams related to Safety and Environment are supplied by the work packages EP3 WP 2.4.3 and WP 2.4.5 respectively.

In this Framework different layers of performance indicators have been defined according to the performance areas. A catalogue of Performance Indicators has also been defined. This catalogue is divided into three layers according to their degree of influence:

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

The validation exercises to be performed in EP3 shall use these Performance Indicators. It will be possible to include new Performance Indicators or modify others in the course of the project.

The SESAR Operational Concept to be validated consists of a number of Performance Target and Operational Improvements (OI). 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.

SESAR develops a Concept Validation Methodology based on European Operational Concept Validation Methodology (E-OCVM), There is mutual awareness of the corresponding EP3 and SESAR activities based on cross participation from the contributing partners.

This framework will describe the methodology to be used to develop a model to build the ECAC picture of SESAR concepts. This model will be developed during 2008. The link (Influence diagrams) between the different layers, PIs and OIs will be identified. The different methodologies proposed to assess the links will be based on a Matrix of weights supported by the:

- Validation exercises;
- Analytical models;
- Expert judgement.

During the 1st cycle the exercises will address the highest layers European Civil Aviation Conference (ECAC) (see Figure 1.Performance Indicators Layers in the Performance Framework) in the pyramid in order to provide the most accurate entries for the ECAC model. If the exercises use metrics outside of this catalogue, the exercises are responsible to provide an integration process to feed the model.

For the second cycle, this framework will be refined with the new indicators and links identified during the first cycle of the project, in improve the accuracy of the ECAC model.

2 INTRODUCTION

2.1 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 build a meaningful “ECAC picture” This will determine “WHAT” will be measured and the contribution of the relevant Operational Improvements are likely to make to the achievement of the targets set out in SESAR D2.

The framework consists firstly of a set of Key Performance Metrics across three performance levels – ECAC-wide, 4 categories of ATM operation, and local Airport and ACC operation – and secondly, the links between Performance Indicators of different characteristics levels. Performance Framework provides a common reference for the measurements that are going to be performed by the EP3 Work Package 3 (WP3), WP4, and WP5 validation exercises.

At this stage, the document presents an initial iteration to be reviewed in consultation with the project participants to ensure it is fit for the purpose it is intended. The Performance Framework will evolve and adapt in the course of the EP3 project.

The Performance Framework will be integrated within the overall Validation Framework developed by EP3 WP2.3.3. This 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 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 are applicable – i.e. “WHEN” and “WHERE” to measure;
- A set of measurement strategies & practices, calibration references and techniques – i.e. “HOW” to measure.

2.2 INTENDED AUDIENCE

The intended audience includes:

- EP3 partners;
- SESAR community.

2.3 DOCUMENT STRUCTURE

The document is structured in three main parts. The first describes the general objectives of the Performance Framework and how the general approach has been designed. The second part presents methodology implemented by the performance framework allowing evaluation of the ECAC wide performance. It includes examples of the application of this methodology. Finally the third part describes a catalogue of Performance Indicators to be used for measurement and integration of the results from the validation exercises.

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3 REFERENCES AND APPLICABLE DOCUMENTS

Ref.	Document	Applicability
[1]	Episode3 proposal	Applicable
[2]	SESAR Performance booklet	Applicable
[3]	SESAR Deliverable 2	Applicable
[4]	Performance Framework	Applicable
[5]	SESAR ConOps	Applicable
[6]	SESAR Definition Phase Concept Validation Methodology WP4.2/Task 4.2.1	Applicable
[7]	ICAO Global Performance Manual (GPM) edition G.0 dated 14 November 2007 (ICAO doc number not yet assigned)	Applicable
[8]	EP3 WP241 Catalogue of PIs and Traceability OI Step vs ECAC PIs.xls	Applicable
[9]	European Operational Concept Validation Methodology (E-OCVM)	Applicable
[10]	SESAR Deliverable 4	Applicable

4 EP3 PERFORMANCE FRAMEWORK LAYERS

The global Performance Framework is based on the definition of SESAR KPAs, Focus Areas and PIs and their targets and how they fit with the requirements defined in the Operational Concept. 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 6 Performance Framework Methodology).

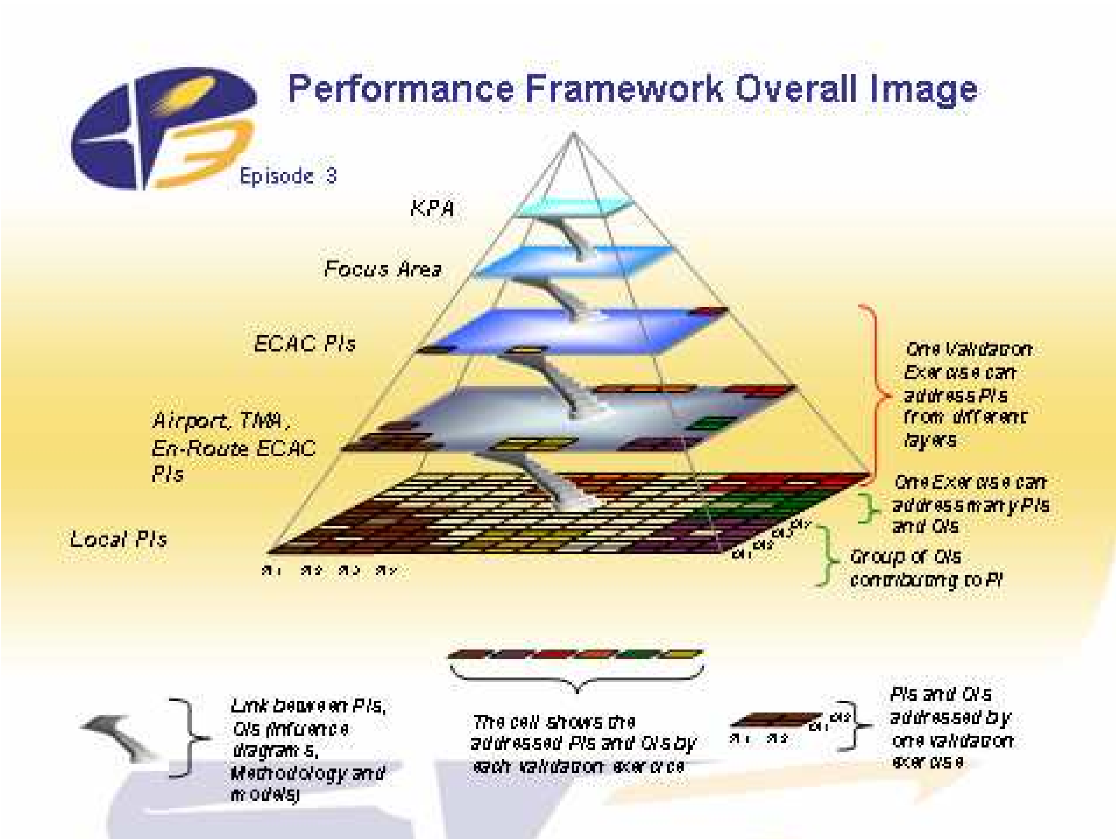

Figure 1.Performance Indicators Layers in the Performance Framework

The figure above shows the different layers of the Performance Framework that are derived from the performance Objectives and Targets described in SESAR D2. Most of the three upper layer targets are available from SESAR. When possible, the targets for the 4th “Airport, TMA, En-route ECAC PIs” and 5th “Local PIs” layers will be derived applying the method that will be explained inside the section 6 Catalogue of Metrics during the development of the methodology until December 2008.

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 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 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 the validation exercise. (see Figure 2.Validation exercises).

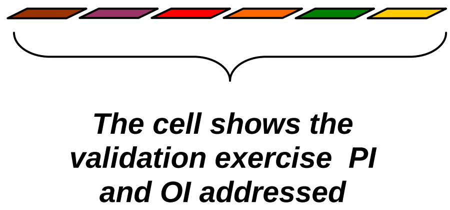

Figure 2.Validation exercises addressed

EP3 validation has been divided into several validation exercises. The validation exercises will perform measurement in different layers -e.g. EP3 WP3 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 3. Validation exercise PI and OI addressed) 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.

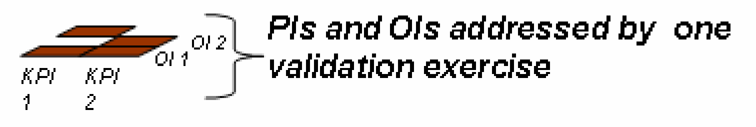

Figure 3.Validation exercises PI and OI addressed

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 4.Link between PIs and OIs (see Influence Diagrams, ECAC Model)) There will not be a complete coverage of the OIs in the validation exercises, this is why the ECAC model will be developed. These gaps will be filled by expert judgment, including data from previous projects and SESAR.

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

The influence diagrams, the methodology and the model will be developed separately by the EP3 WP2.4.1 during 2008 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.

4.1 Key Performance Areas and their Targets

Key Performance Areas and targets from SESAR D2 to be addressed in Episode 3 are the political KPAs: Capacity, Environment, Safety and the Quality of Service KPAs: Efficiency, Predictability and Flexibility.

Environment and Safety have dedicated work packages. The safety assessment will be developed in WP2.4.3 and the Environmental Assessment will be developed in Episode 3 WP2.4.5. 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. At the ECAC level the Performance Targets have been defined by SESAR, when possible these targets will be derived for the lower level of Performance Indicators.

4.1.1 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.

4.1.2 Environmental Sustainability

Aviation has a diverse impact on the environment, but not all aspects can be influenced by the ATM System. This KPA addresses the role of ATM in the management and control of environmental impact. The aims are to reduce adverse environmental impact (average per flight); to ensure that air traffic related environmental considerations are respected; and, that as far as possible new environmentally driven non-optimal operations and constraints are avoided or optimised as far as possible. This focus on the environment must take place within a wider "sustainability" scope that takes account of socio-economic effects and the synergies and trade-offs between different sustainability impacts.

The performance assessment during D3 has been driven by the target of reducing CO_2 emissions by 10% per flight (European-wide annual average).

Bearing in mind that the Initial Shared Business Trajectory (ISBT) incorporates ATM strategic constraints, CO_2 emission per flight can be reduced by:

- Reducing the reference fuel consumption with more fuel-efficient ISBT based on:
  - The removal of strategic constraints that prevent flying a fuel efficient trajectory (especially in the vertical plane). A typical example is the replacement of stepped approach profiles by CDAs;.
  - The selection of cost index that favours fuel saving. However, this factor is driven by business trade-offs made by operators prior to filing the ISBT. It is not part of the ATM factors;
- Reducing the excess fuel on top of the reference fuel consumption through “undisturbed” flight execution, meaning that traffic synchronisation and separation provision actions do not incur too many fuel-consuming deviations from the ISBT.

The CO_2 emission reduction target is a European wide annual average. The actual achievement will result from aggregating achievements in different operational contexts. Typically:

- In low/medium complexity airspace where route structure exists today and level capping constraints are applied (for instance related to ACC boundaries), the removal of the corresponding constraints, allowing for instant cruise climb on direct routes (or continuous descent approaches in TMAs), will provide significant contribution to meeting the target;
- In high complexity airspace, especially complex TMAs, the current SID/STAR structure will be replaced by more optimised 3D separated routes that could reduce the excess fuel consumption, but are not yet fuel optimal;
- In addition, relaxing ATM constraints at non-busy hours improves the average.

4.1.3 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 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.

4.1.4 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.

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4.1.5 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[1] before or after the time reference), Service disruption effect and knock-on effects.

4.1.6 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 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.

4.2 Focus Areas

4.2.1 Capacity Focus Areas

4.2.1.1 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.

[1] SESAR D2 §3.4.5.2, P84/149

4.2.1.2 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) in the airside-landside value chain, 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"[2] value available 365 days per year, from 0700 till 2200 hrs local time:

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

4.2.1.3 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[3].

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.

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[2] 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

[3] SESAR D2 §3.4.2.2 P79/149

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4.2.2 Environment Focus Areas

4.2.2.1 Environmental constraint management

This focus area covers the broad responsibility of the ATM decision makers (e.g. environmental lawmakers, environmental regulators, local planning authorities and local rule makers) to avoid imposing any unnecessary environmentally driven constraint or non-optimal operational practice or constraints without incentives.

The aim is that all proposed environmentally related ATM constraints would be subject to a transparent assessment with an environment and socio-economic scope; and, following this assessment the best alternative solutions from a European Sustainability perspective are seen to be adopted.

4.2.2.2 Best ATM Practice in Environmental Management

This Focus Area covers ATMs ability to optimise the environmental performance of aircraft operations, ensuring that the environmental benefits arising from such improvements are assessed and recognised by the Sustainability Framework for ATM.

Local environmental rules affecting ATM are to be 100% respected "e.g. aircraft type restrictions, night movement bans, noise routes and noise quotas". Exceptions are only allowed for safety or security reasons.

4.2.2.3 Compliance with environmental rules

This Focus Area covers the degree to which environmentally driven traffic rules and constraints imposed on airports and airspace are respected.

4.2.2.4 Atmospheric Impacts

This Focus Area covers gaseous emissions "-i.e. CO_2, NO_x, H_2O", particulates and secondary effects (such as contrail triggered cirrus) generated in all flight phases (taxi, departure/arrival, en-route), and their impacts on both local air quality and the global climate.

Achieve the implicit emission improvements through the reduction of gate-to-gate excess fuel consumption addressed in the KPA Efficiency. However no specific separate target could be defined at this stage for the ATM contribution to atmospheric emission reductions.

Minimise other adverse atmospheric effects to the greatest extent possible. Suitable indicators are yet to be developed.

4.2.2.5 Noise Impacts

This Focus Area covers noise generated during all flight phases (en-route = sonic boom) and its impact on affected population.

Noise emissions and their impacts are minimised for each flight to the greatest extent possible.

4.2.3 Safety Focus Areas

4.2.3.1 ATM-related safety outcome

Safety criteria define the level of acceptable 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*". 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. This is only meaningful for collisions between two aircraft, and therefore the original ATM2000+ metric is more useful for single-aircraft accidents.

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;
- 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 and ESARR 2:
- 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);

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- Traffic - all types of aircraft with 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).

Compliance with the SESAR safety design target is considered to 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 levels over that period.

4.2.4 Efficiency Focus Areas[4]

4.2.4.1 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 Of Block Time (EOBT) as defined in the last occurrence of the Shared Business Trajectory (SBT) 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 (normal flight duration is defined as actual block-to-block time less than 3 minutes longer than the block-to-block time of the Shared Business Trajectory; extended flight duration 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.

4.2.4.2 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 Shared Business Trajectory) will be addressed by:

- 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%.

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

4.2.4.3 Mission Effectiveness

Following military trajectory models focus is to reflect the economic impact of transit times associated with military training activities.

4.2.5 Predictability Focus Areas[5]

4.2.5.1 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% (European-wide annual average) of flights suffering arrival delay of more than 3 minutes;
- Arrival delay: the average delay (European-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 is 0.015 (meaning for a 100-minute flight duration more than 95% flights arrives on-time, according to arrival punctuality target).

4.2.5.2 Service Disruption Effect[6]

Focus 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 goal is to reduce cancellation rates by 50% by 2020 compared to 2010 baseline, reduce diversion rates by 50% by 2020 compared to 2010 baseline and reduce total disruption delay by 50% (European-wide annual average) by 2020 compared to 2010 baseline.

4.2.5.3 Knock-on effect

Focus is on the impact of (a lack of) 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.

Reducing reactionary delay by 50% by 2020 compared to 2010 baseline and reduce cancellation rate by 50% (European-wide annual average) by 2020 compared to 2010 baseline.

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

[6] 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%).

4.2.6 Flexibility Focus Areas[7]

4.2.6.1 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 BT 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% (European-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 (European-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% (European-wide annual average) of the (valid) requests for full Reference Business Trajectory (BT) 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 Reference BT redefinition, no more than 10% of the flights (European-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 Reference BT redefinition (with a delay penalty of more than 3 minutes) will be less than 5 minutes.

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

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

4.2.6.3 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% (European-wide annual average) of the VFR-IFR change requests will be accommodated without penalties.

4.2.6.4 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.

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

5 INFLUENCE DIAGRAMS

5.1 ORIGIN, PRINCIPLES AND NOTATIONS

Several people from the decision-analysis community have been involved in the creation of influence diagrams. Professor Ronald Howard from Stanford University and Dr James Matheson, refined and popularised influence diagrams as a convenient notation for communicating about decision problems.

"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".

There is a mathematical theory related to influence diagrams that gives them a precise meaning and allows resolving them. This theory can be found in reference texts[8] for further information, but we do not intend to apply the theory as such. Influence diagrams will be used rather as a convenient notation for supporting expert judgment activities and specific computations when feasible.

Beyond the core mathematical theory, there is no standard influence model definition. However, the various flavours of influence models presented in documents and/or implemented in software tools[9] share common principles and present similarities between their graphical syntax for influence diagrams.

Nodes are often distinguished to reflect the elementary decisions that can be made, the criteria that drive the decisions, and the factors that cannot be controlled.

The graphical notation is a directed acyclic graph with nodes that contain variables and links connecting the nodes. The variable in a given node is influenced by the variables in the predecessor nodes in the graph. This influence can be expressed in a qualitative or quantitative manner. Quantification can be deterministic or probabilistic. SESAR WP2.3.1 influence diagrams will be used as a starting point for this activity. The graphical notation is illustrated by Figure 5.Graphical notation for influence modelling. It is a bipartite graph with two types of nodes: variable nodes and mechanism nodes. Variable nodes are distinguished as explained below.

[8] Seminal papers are mostly Operation Research journals articles published about 20 years ago that need to be purchased from the publisher. However, many papers available on the Web today recall the basic theory before presenting enhancements or application cases. Text books on OR, Decision Theory or Artificial Intelligence include chapters on probabilistic inference and influence diagrams. For instance, an introduction can be found in Russell & Norvig "Artificial Intelligence, A Modern Approach". 2nd Edition, Prentice Hall, 2003.

[9] One example is Analytica from Lumina Decision Systems: www.lumina.com

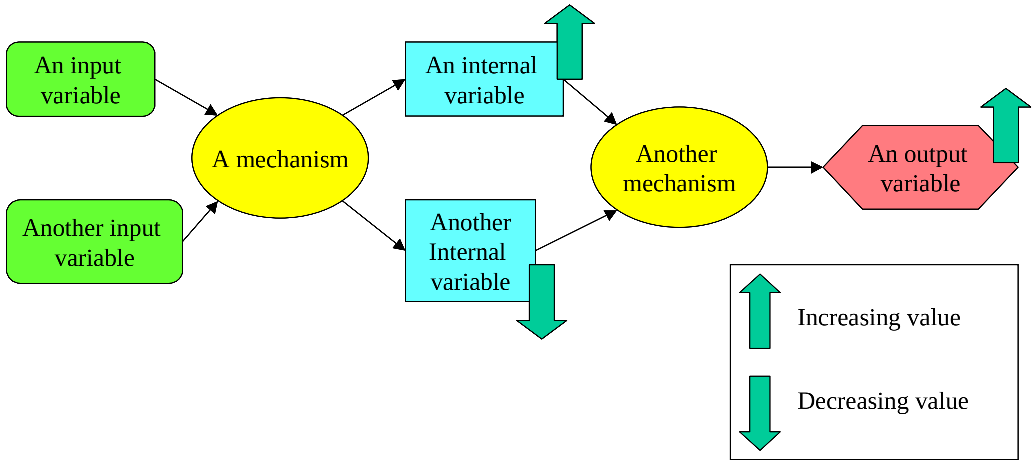

Figure 5.Graphical notation for influence modelling

The nodes are defined as follows:

- Mechanism. A mechanism specifies the dependencies between the variables in its predecessor nodes (the input variables of the mechanism) and the variables in its successor nodes (the output variables of the mechanism). The mechanism can be:

  A description of qualitative dependencies;

  A description of quantitative dependencies in various forms: “e.g. mathematical expression, tables”;

- Input variable node. An input variable node is a variable node with no input mechanism node. Input variable nodes are used to denote:

  Unconditional decisions like “implement brake to vacate”;

  Context variables like “operational environment”;

- Internal variable. An internal variable node is a variable node that has one mechanism predecessor node and one or more mechanism successor nodes, and is not tagged as output variable node;

- Output variable node. Output variable nodes are used to denote criteria that drive the decision making process. An output variable node is either:

  A variable node with no output mechanism node;

  Or an internal variable tagged as output variable node.

The vertical arrows are visual indications of the evolution of intermediate variables and output variables, assuming that some input variables denote decisions like “implement system XX” or “provide service YY”. Compared to expectations associated to variables like “efficiency should increase” or “task demand should decrease”, they can be coloured:

- In green for denoting beneficial evolution compared to the expectation;

- In red for denoting adverse evolution compared to the expectation.

Note that this applies only to a restricted form of diagram where input variables have domain values that determine unambiguously the evolution of internal variables. The typical example is the analysis of the effect of deploying a new service as done for CASCADE: there is one binary input variable that denotes the introduction of the service compared to the “do-nothing” case.

5.2 REVISION OF THE INITIAL INFLUENCE DIAGRAMS PROVIDED BY SESAR T231 D4

SESAR WP2.3.1 provided two different sets of influence diagrams for SESAR D3 and SESAR D4. This section focuses on the work done in the context of D4 (qualitative and some quantitative assessments) and, therefore, there are some differences with respect to the work done in the context of D3 (see previous section) in terms of notations. Both contributions will be used as inputs by EP3.

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).

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 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 are called Influence Diagrams[10]. There is such a diagram for each performance category which is 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 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.

The tree-like diagrams map through from the main operational characteristics and influencing factors to performance outputs. The base influence factors are the leaves in those trees.

The quantitative assessment consisted of retrieving suitable baselines, 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 contributions from the main factors can be estimated. This requires the assessor(s) to have a good baseline 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.

The following performance categories were listed and for each of them an Influence Diagram was produced: Airspace Capacity, Airport Capacity, Predictability, Fuel Efficiency, Time Efficiency, Flexibility, Disrupted service and Cost Effectiveness.

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[10] 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 assessments were performed as follows:

- Influence Diagrams definition;
- Mapping of Operational 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.

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. For instance, Airport Capacity was assessed based on the following influence diagram:

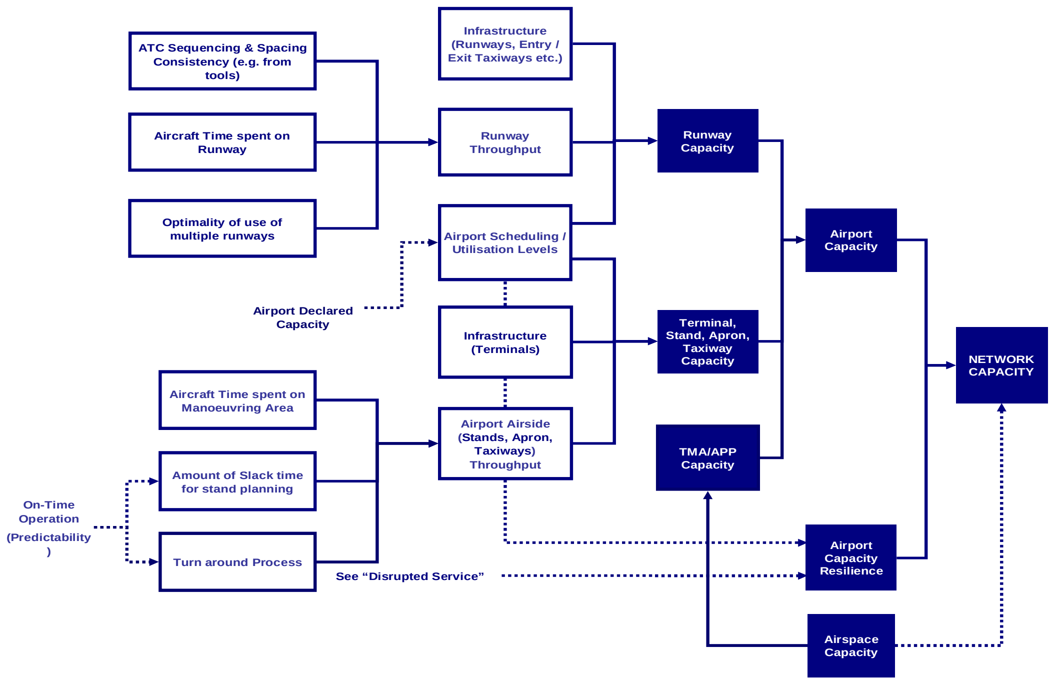

Figure 6 Example of Influence Diagram for Airport Capacity

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6 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 an 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 Deliverable 1 and Deliverable 2 has set the initial state needed to build the ECAC Model. In section 6.1 ECAC Model Methodology, the methodology to create the ECAC Model will be defined. The model itself will be developed during 2008.

The output from the validation exercises should feed the ECAC Model, directly if there is a direct relationship between outputs and the Catalogue of Performance Indicators, or indirectly if not, i.e. if the platforms do not allow performance to be measured in terms of any of the metrics (or too late to change them). In this case each WP is responsible for post-processing the exercise outputs trying to adapt them to the established Performance Indicators collected in the Catalogue. This means that if a validation exercise defines its own performance indicators to provide results, then the validation exercises will have to integrate those measures into ECAC Model valid performance indicators in order to enable a correct continuation of the performance assessment process. In section 6.2 Integration of the EP3 validation exercises in the Performance Framework, the Performance Framework provides guidelines to the validation exercises and WPs in order to develop their integration processes, these guidelines will be discussed and agreed with the exercises during 2008.

The management of the uncertainty inherent in experiment/exercises will be 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 several tasks will contribute to the development of an ECAC Model. The influence diagrams will 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.

6.1 ECAC MODEL METHODOLOGY

EP3 will develop a set of validation activities to assess the 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 the validation activities with the KPAs in order to assess how the KPAs are affected by the new concepts.

The Performance Framework must provide the methodology to create a performance assessment, called ECAC Model, and also the instructions to use it. The performance assessment system will integrate the results, coming from the validation activities that will be held in EP3 WP 3, 4 and 5, into the internal structure of the ECAC Model. The outcome of the ECAC Model will be projections in the KPAs and PIs which will be comparable with the KPAs and PIs targets of the Performance Framework. The projections will be originated by the values obtained in the exercises execution, 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 4 EP3 Performance Framework Layers and 7 Catalogue of Performance indicators for more information about KPAs and PIs targets.

The ECAC Model consists of an internal structure of links between the different layers of performance indicators defined in Section 4 and 7. These layers and the links between the performance indicators of one layer and the performance indicators of another layer, 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 6.1.3 *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 PIs that are causing that effect. It is important to notice that WP 2.4.1 will develop an ECAC model that will be able to measure the performance related to 4 KPAs, these are Capacity and QoS (Flexibility, Efficiency and Predictability), the KPAs Environment and Safety have their own related work packages. The results coming from those work packages will be able to be integrated into the ECAC Model.

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 Deliverable 2, 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;

- Define the integration map that connects different indicators through causal links. The integration map establishes cause-effect relationships between the strategic objectives, 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 performance assessment. The integration map will be composed by the influence diagrams that show the cause-effect relationships.

  Influence diagrams have partially been done in SESAR D3 deliverable and further developed in SESAR D4 deliverable. In SESAR D3 deliverable benefit mechanisms were identified and links between Key Performance Areas, main SESAR objectives, and concept elements were described. In SESAR D4 deliverable new links were identified between KPA, Focus Areas, and Operational Improvements. There is still a lot of work to be done by WP241 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 targets for the performance indicators layers and define the mathematical models (mathematical formulas and weight matrixes), analytical models and fast time simulations to integrate the values of the performance indicators from one layer to the higher layer in order to obtain the performance assessment. Other possible approaches could be provided for the integration process during the development of the influence diagrams, like other kinds of simulations or modelling. The ECAC model will be developed and finished in Feb 2009. see Annex IV. Planning.

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

Two risks have been identified: not all the cause-effect linkages have been described at this moment. This risk is minimised, as this work package, WP2.4.1, will continue developing influence diagrams.

The second risk is that validation exercises may provide outputs using performance indicators other than those described in the Catalogue and for which the ECAC Model is designed. In such cases, there will be a need to transform the measures into valid performance indicators for the ECAC Model.

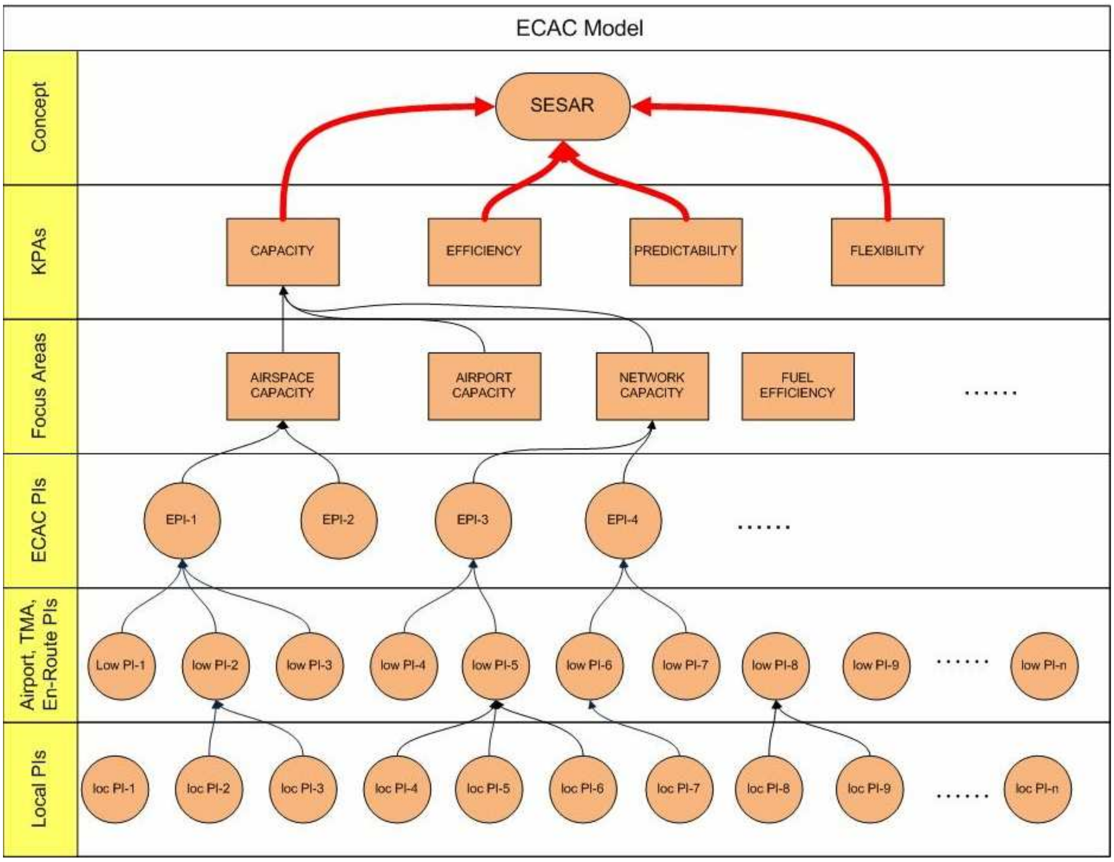

Figure 7 ECAC Model

6.1.1 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 4 EP3 Performance Framework Layers.

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

As it is said in section 5.1, the WP 2.4.1 is in charge of developing an ECAC model that will be able to measure the performance related to 4 KPAs, these are Capacity and QoS (Flexibility, Efficiency and Predictability), the KPAs Environment and Safety have their own related work packages. It will be possible to integrate the results coming from the work done by those work packages into the ECAC Model.

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.

6.1.2 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 performance indicators 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 performance indicator of the higher level will be described in the next section.

Inside the WP3, WP4 and WP5, the validation exercises focus on some OI Steps in order to assess the concepts included in the SESAR CONOPS. A validation 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. If some of those outputs are not listed in the Catalogue of Performance indicators there is the need to integrate those outputs into valid Performance Framework indicators. The Performance Framework will provide the validation exercises with the guidelines on how to carry out the integration processes.

With the information provided by the Performance Framework and the validation exercises, it will be possible to analyze which indicators are not needed and which are missed.

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 2008 will complete the traceability between the different PIs layers.

6.1.2.1 First Level. KPAs

The KPAs included in the architecture of the ECAC Model are Capacity and QoS, understanding QoS as the following: Efficiency, Flexibility and Predictability. 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 targets and create part of the traceability in the ECAC Model in order to facilitate the future extension of the assessment system.

The table below shows the KPAs defined in SESAR D2.

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

6.1.2.2 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.

The table below shows the Focus Areas defined in SESAR D2 within each of the KPAs.

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	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
KPA-6	Safety	FA-18	ATM-related safety outcome

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6.1.2.3 Third Level. ECAC PIs

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

The table below shows the ECAC PIs by Focus Area. They have been extracted from the Influence Diagrams created by the Task Force in charge of the “SESAR Capacity & Quality of Service Performance Assessment Task Report”.

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

6.1.2.4 Fourth Level. Airport, TMA, En-Route ECAC PIs

This layer will be an intermediate level between the Local Performance Indicators and the higher layers. This level will represent the ECAC picture in terms of global PIs 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 at this level.

The traceability to ECAC PIs layer indicators from this layer will be created by the Influence Diagrams that will be developed during 2008.

6.1.2.5 Fifth level. Local Performance Indicators

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

The traceability to Airport, TMA, En-Route ECAC PIs layer indicators from this layer will be created by the Influence Diagrams that will be developed during 2008.

6.1.3 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 performance indicators among the performance indicators layers of 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 PIs layers, like mathematical models, analytical models and fast time simulation. Other kinds of simulations and modelling techniques could be proposed during 2008 in order to complete the set of proposed ones. The following paragraphs focuses on the use of a mathematical model for the integration processes inside the Performance Framework.

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

The weight matrix will hold the coefficient values of the mathematical formulae, i.e. the weight of influence of the performance indicators of a lower layer on the performance indicator of a higher layer. 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.

The mathematical formula associated with a performance indicator 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.

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

- Assign the weight of the performance indicators. Not all the performance indicators will have the same influence in a higher indicator. An accurate performance assessment system depends on precise coefficient values being derived;
- Establish the formulae 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. If there is no mathematical formula, then the EP3 WP2 will be asked to provide support in order to develop a formula or similar (e.g. by conducting further fast time simulations).

It is not an easy task to derive the weights and the formulas 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 does use neither real data nor real formulas.

In this example we will assign the following names:

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.

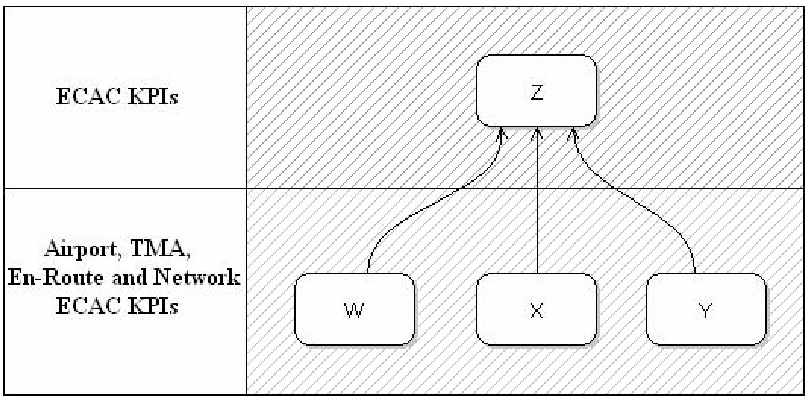

Figure 8 Influence between the layers of the ECAC Model

The variables W, X and Y will have an influence on the value of variable Z, this influence is modelled using the weight matrix. The weight matrix associated with the Airport, TMA, En-Route ECAC PIs layers will provide the coefficients of the formula to calculate the variable Z. These coefficients will be a1, a2 and a3.

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. The mathematical formula can be very complex, for instance non-measurable factors could be added to the formula as noise effects.

$$Z = a1 * W + a2 * X + a3 * Y$$

This is a simple example with the objective of explaining the ECAC Model. The next section provides wider examples.

6.2 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 7 should be used in all exercises. This catalogue will allow all the partners in EP3 and outside the project to speak the same language.

New Performance Indicators may be defined in the exercises but it is recommended to conform to the library when possible. These Performance Indicators should be published and this WP will incorporate them for the 2nd cycle.

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 transformation process will be done by the WP2.4.1 and each exercise in 2008.

The EP3 project will provide a first assessment of 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 concept);
- limited operational contexts.

Therefore, an integration process in order to obtain a 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 in order to obtain a global view on the performance of the 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 set of weights and the formulae 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 set of detailed influence diagrams that will help to climb up the stairs of the pyramid. These influence diagrams will use

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as inputs material produced by the SESAR definition phase (T231/D4 assessment), "i.e. past studies, expert judgment".

6.2.1 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.

6.2.1.1 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.

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: 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 Report11:

- 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).

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

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;

- 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

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

Best in Class Airport enhancements[12]

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;
- 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.

6.2.1.2 *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).

[12] 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)

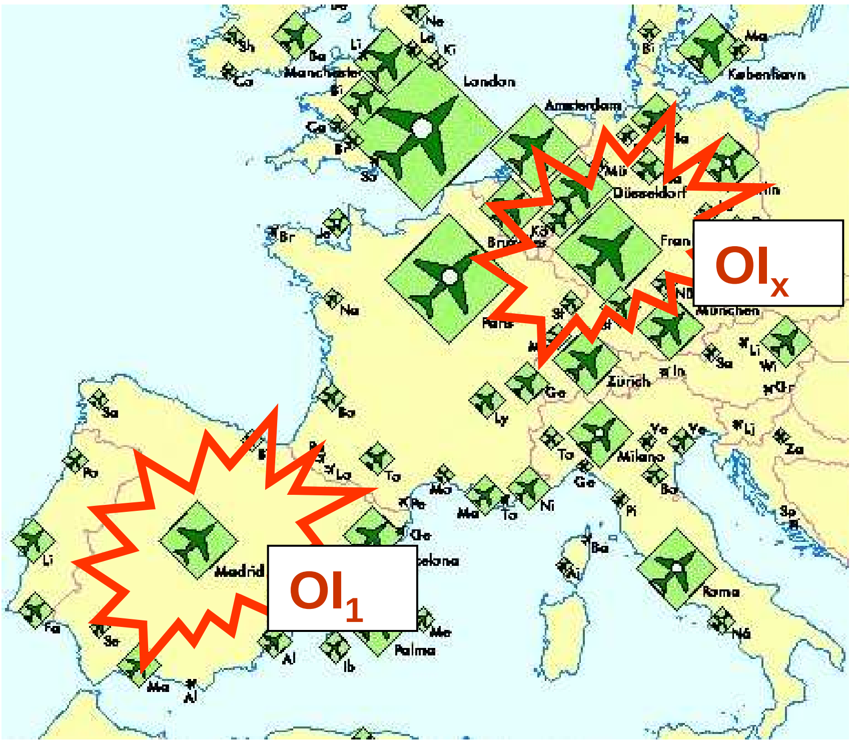

Figure 9 EP3 Validation Exercises on Airports

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).

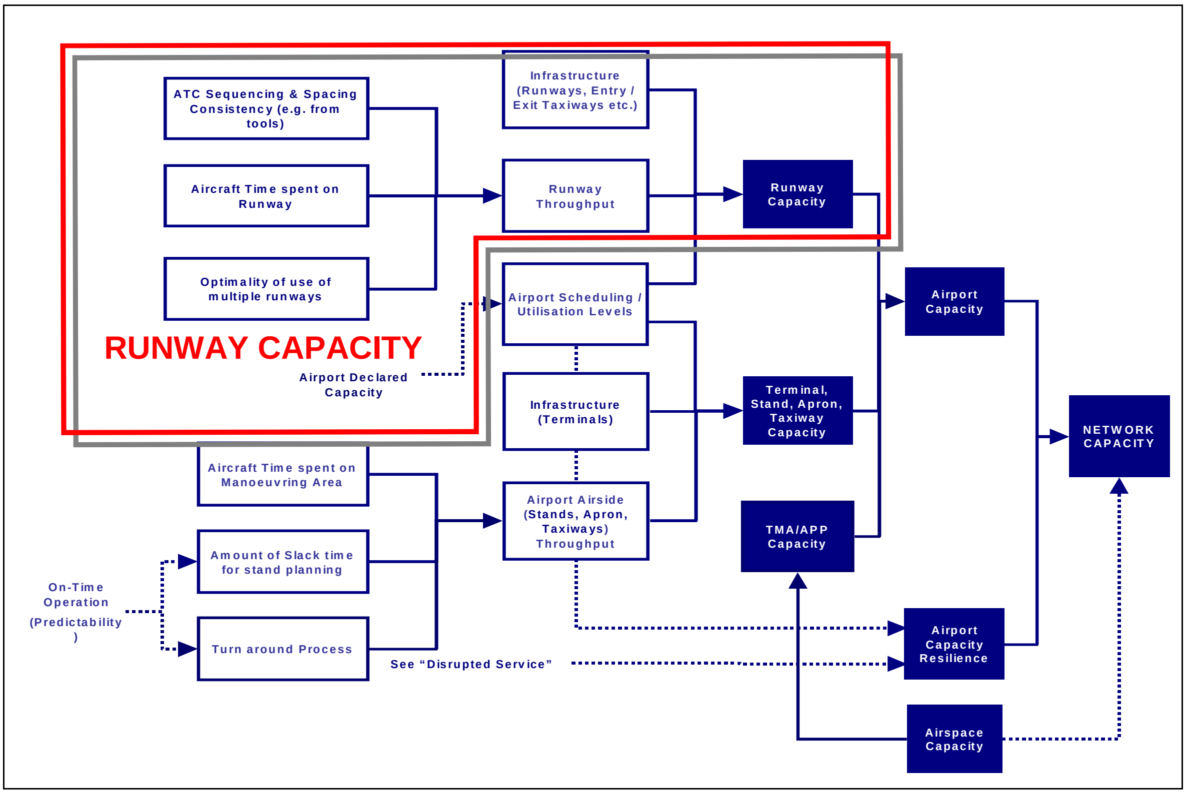

Figure 10 SESAR T231 / D4 [10] Influence Diagram "Airport Capacity"

The following table 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.

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									

Figure 11 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 have 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 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 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.

6.2.1.3 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 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, that will be done during 2008, 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 activities involve ECAC wide assessment and it is necessary to define the link between exercises performed in WP3, WP4 and WP5 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 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, WP4 and WP5 validation exercises will be extrapolated from the local operational context according to the classification of airports/TMAs/airspace identified in the previous step.

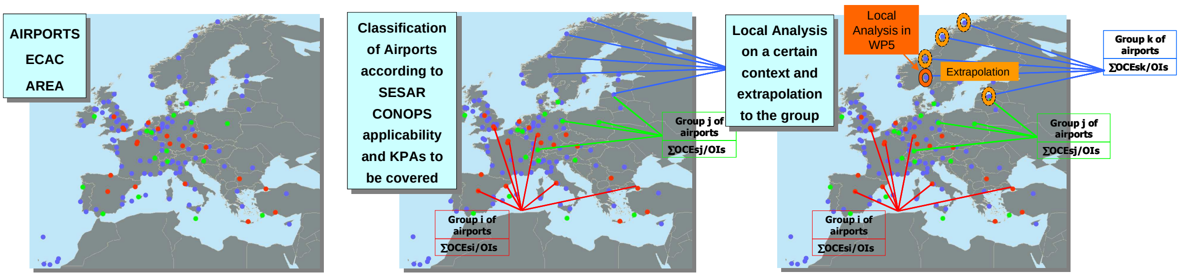

Figure 12.Example of methodology application: Airports (steps 1 and step 2)

The **third step** of the methodology will consist of the integration of results from the WPs into a model that therefore will provide an overall performance at the ECAC Wide Area. The model is a mixture of models, queue model, process model and likely FTS components that intends to perform the ATM ECAC network in high level of detail. Since the validation exercises performed in the 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.

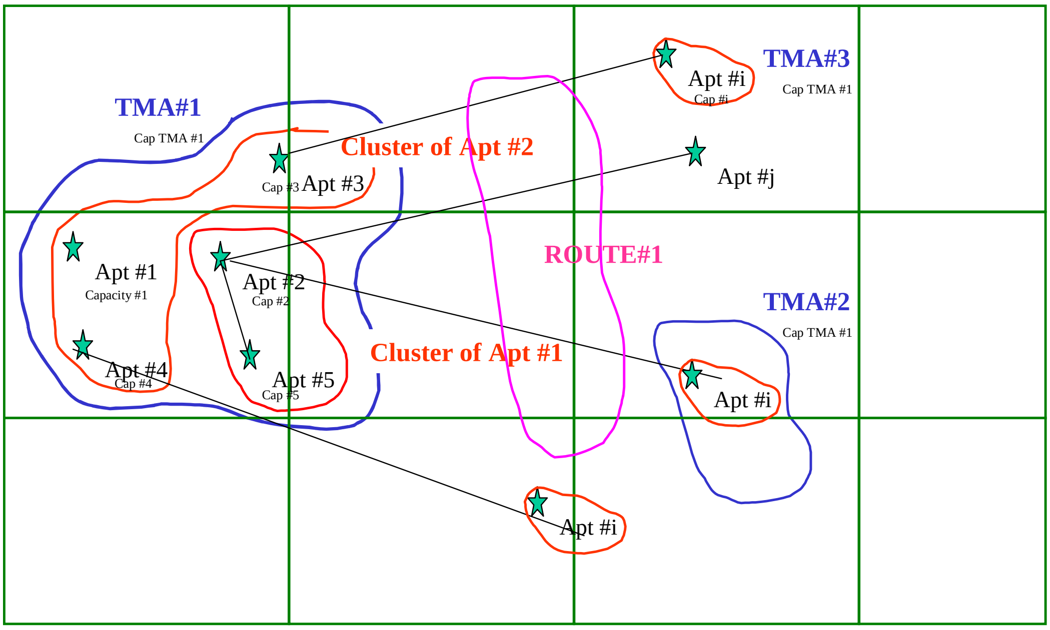

Figure 13.Model

This model implies a modelling process but it considers the effect of the nodes (individual airports, TMAs, airspace) on the network.

Mathematical formula

The mathematical formulae could be provided by the influence diagrams through expert judgment.

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.

7 CATALOGUE OF PERFORMANCE INDICATORS

This section will be 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. When possible these targets will have to be derived for the lower level of Performance Indicators. 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.

7.1 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.

7.1.1 ECAC Performance Indicators for Capacity

7.1.1.1 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.

7.1.1.2 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 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: To be determined.

7.1.2 ECAC Performance Indicators for Environment

7.1.2.1 Objectives

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

7.1.2.2 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%.

ENV.ECAC.PI 2: Annual CO2. Total annual amount of CO2 divided by number of movements.

ENV.ECAC.PI 2.TG: Reduction by 10%.

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%.

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%.

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%.

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

ENV.ECAC.PI 6.TG: Reduction by 10%.

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

ENV.ECAC.PI 7.TG: Reduction by 10%.

ENV.ECAC.PI 8: Number of Population exposed to Noise Level:

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

ENV.ECAC.PI 8.TG: Reduction by 10%.

7.1.3 ECAC Performance Indicators for Safety

7.1.3.1 Objectives

To evaluate the Safety of the future ATM System.

7.1.3.2 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.

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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).

7.1.4 ECAC Performance Indicators for Efficiency

7.1.4.1 Objectives

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

7.1.4.2 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 flight 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.

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

EFF.ECAC.PI 5: Percent of flight 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%.

7.1.5 ECAC Performance Indicators for Predictability

7.1.5.1 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*.

7.1.5.2 Proposed Indicators

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

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

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

PRED. ECAC.PI 2.TG: Arrival delay: the average delay (European-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.

7.1.6 ECAC Performance Indicators for Flexibility

7.1.6.1 Objectives

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

7.1.6.2 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.

FLX.ECAC.PI 1.TG: At least 95% (European-wide annual average) of the (valid) requests for full Reference Business Trajectory (BT) 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 Reference BT redefinition, no more than 10% (European-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 (European-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% (European-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 (European-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% (European-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: Not defined.

FLX.ECAC.PI 8: Utilization of Airspace. 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.PI 8.TG: Not defined.

7.2 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.

7.2.1 ECAC Performance Indicators for Airport

7.2.1.1 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: If possible to be derived from target above.

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: If possible to be derived from target above.

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: If possible to be derived from target above.

7.2.1.2 Proposed PIs for Airport Environment

This section will be developed by EP3 WP 245.

7.2.1.3 Proposed PIs for Airport Safety

Foreword (applies similarly to sections 7.2.2.3 and 7.2.3.3):

From the SRC Annual Safety Report: 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 7.2.1.3, 7.2.2.3 and 7.2.3.3, 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 2008. 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 sections 4.2.3.1 and 7.1.3.

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: If possible to be derived from target above.

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

SAF.ECAC.APT.PI 2. TG: If possible to be derived from target above.

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: If possible to be derived from target above.

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 are 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:

  Failure to follow the correct taxi route to the runway entry point;

  Failure to follow the runway entry instructions.

SAF.ECAC.APT.PI 4. TG: If possible to be derived from target above..

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:
  Failure to communicate appropriate avoidance instructions;
  Pilot failure to take the instructed avoidance action.

SAF.ECAC.APT.PI 5. TG: If possible to be derived from target above.

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

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

SAF.ECAC.APT.PI 6. TG: If possible to be derived from target above.

Taxiway Collision:

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

SAF.ECAC.APT.PI 7. TG: If possible to be derived from target above.

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

SAF.ECAC.APT.PI 8. TG: If possible to be derived from target above.

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

SAF.ECAC.APT.PI 9. TG: If possible to be derived from target above.

7.2.1.4 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 1minutes, 2 minutes, 3 minutes or more after the departure time of the Initial Shared Business Trajectory".

EFF.ECAC.APT.PI 1.TG: Occurrence (punctuality); If possible to be derived from target above.

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 1minutes, 2 minutes, 3 minutes or more. after the departure time of the Initial Shared Business Trajectory".

EFF.ECAC.APT.PI 2.TG: Severity (Delays): If possible to be derived from target above.

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 1minutes, 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; If possible to be derived from target above.

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 1minutes, 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: If possible to be derived from target above.

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; If possible to be derived from target above.

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: If possible to be derived from target above.

7.2.1.5 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 1minutes, 2 minutes, 3 minutes".

PRED.ECAC.APT.PI 1.TG: If possible to be derived from target above.

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

PRED.ECAC.APT.PI 2.TG: If possible to be derived from target above.

7.2.1.6 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: If possible to be derived from target above.

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

FLX.ECAC.APT.PI 2.TG: If possible to be derived from target above.

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 1minutes, 2 minutes, 3 minutes or more.

FLX.ECAC.APT.PI 3.TG: If possible to be derived from target above.

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: If possible to be derived from target above.

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

FLX.ECAC.APT.PI 5.TG: If possible to be derived from target above.

7.2.2 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 a *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.

7.2.2.1 Proposed PIs for TMA Capacity

- CAP.ECAC.TMA.PI 1: 1h capacity (Nb aircraft/h). *M*aximum 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 that 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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7.2.2.2 Proposed PIs for TMA Environmental Sustainability

- ENV.ECAC.TMA.PI 1: Total Fuel consumption (kg). Total fuel consumption, which is the sum of the fuel consumptions of all aircraft flying in the geographic area. Only the fuel burnt in during the scenario in its geographic area should be considered;
- ENV.ECAC.TMA.PI 2: Affected Population (no unit). Number of people in the vicinity of the airports included within the limits of the Lden noise contour at 55dB. Lden is the Community noise equivalent Day-evening-night level. It is a descriptor of noise level based on energy equivalent noise level (Leq) over a whole day with a penalty of 10 dB(A) for night time noise (22.00-7.00) and an additional penalty of 5 dB(A) for evening noise *–i.e. 19.00-23.00.* The definition of the noise contour should be the same as for airport performance indicators.

Mean fuel consumption can be computed from *fuel consumption*. Note that fuels PIs are also relevant for Efficiency.

7.2.2.3 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.

7.2.2.4 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

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performances. (See the beginning of the 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;
- 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.

7.2.2.5 Proposed PIs for TMA Flexibility

- FLX.ECAC.TMA.PI 1: BT 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).

7.2.2.6 Proposed PIs for TMA Predictability

- PRE.ECAC.TMA.PI 1: Unpredictable Deviation (min). *Unpredictable deviation* depends on how airspace users estimate flight times. As 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.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.

7.2.3 ECAC Performance Indicators for En-Route

7.2.3.1 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: If possible to be derived from target above.

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: If possible to be derived from target above.

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: If possible to be derived from target above.

7.2.3.2 Proposed PIs for En-Route Environment

This section will be developed by EP3 WP 4.2.5.

7.2.3.3 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: If possible to be derived from target above.

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: If possible to be derived from target above.

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: If possible to be derived from target above.

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

SAF.ECAC.ER.PI 4.TG: If possible to be derived from target above.

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

SAF.ECAC.ER.PI 5.TG: If possible to be derived from target above.

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: If possible to be derived from target above.

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: If possible to be derived from target above.

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

SAF.ECAC.ER.PI 8.TG: If possible to be derived from target above.

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: If possible to be derived from target above.

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: If possible to be derived from target above.

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

SAF.ECAC.ER.PI 11.TG: If possible to be derived from target above.

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

SAF.ECAC.ER.PI 12.TG: If possible to be derived from target above.

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: If possible to be derived from target above.

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

SAF.ECAC.ER.PI 14.TG: If possible to be derived from target above.

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: If possible to be derived from target above.

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

- 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: If possible to be derived from target above.

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: If possible to be derived from target above.

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: If possible to be derived from target above.

7.2.3.4 Proposed PIs for En-Route Efficiency

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

EFF.ECAC.ER PI 1.TG: If possible to be derived from target above.

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

EFF.ECAC.ER PI 2.TG: If possible to be derived from target above.

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

EFF.ECAC.ER PI 3.TG: If possible to be derived from target above.

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: If possible to be derived from target above.

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

EFF.ECAC.ER.PI 5.TG: If possible to be derived from target above.

7.2.3.5 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. If possible to be derived from target above.

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: If possible to be derived from target above.

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

PRED.ECAC.ER PI 3.TG: If possible to be derived from target above.

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

PRED.ECAC.ER PI 4.TG: If possible to be derived from target above.

7.2.3.6 Proposed PIs for En-Route Flexibility

FLX.ECAC.ER PI 1: Average delay due to BT 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: If possible to be derived from target above.

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: If possible to be derived from target above.

FLX.ECAC.ER.PI 3: Flights delayed due to BT 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: If possible to be derived from target above.

FLX.ECAC.ER.PI 4: Average delay due to BT 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: If possible to be derived from target above.

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

FLX.ECAC.ER.PI 5.TG: If possible to be derived from target above.

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

FLX.ECAC.ER PI 6.TG: If possible to be derived from target above.

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

FLX.ECAC.ER PI 7.TG: If possible to be derived from target above.

7.3 LOCAL PERFORMANCE INDICATORS

7.3.1 Local Performance Indicators for Airports

7.3.1.1 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 movements per hour:

  TARGET:

  60 movements per hour in VMC (and 48 movements per hour in IMC) for airport with a single runway (also airports with converging runways);

  90 movements per hour in VMC (and 72 movements per hour in IMC) for airport with parallel but dependent runways;

  120 movements per hour in VMC (and 96 movements per hour in IMC) 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;.

- 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. 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.

7.3.1.2 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 T 2.1.2). 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;

    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.

7.3.1.3 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.

7.3.1.4 Proposed Performance Indicators for Airport Flexibility

The indicators provided by T 2.1.2 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.

7.3.1.5 Proposed PIs for Environmental Sustainability

The following indicators for environmental sustainability are proposed:

- ENV.LOCAL.APT.PI 1: Total Fuel consumption (kg): it is not evident to obtain this PI exclusively for the airport operation;
- ENV.LOCAL.APT.PI 2: Mean Fuel consumption (kg/aircraft): ratio between the total fuel consumption and the total airport throughput;
- ENV.LOCAL.APT.PI 3: Total emissions (kg): especially CO_2 emissions (difficult to be obtained exclusively for the airport);
- ENV.LOCAL.APT.PI 4: Noise Footprints / Noise Contours around the airport: provided as contours over the airport map in terms of:

  Lden: Community noise equivalent Day-evening-night level. It is a descriptor of noise level based on energy equivalent noise level (Leq) over a whole day with a penalty of 10 dB(A) for night time noise (22.00-7.00) and an additional penalty of 5 dB(A) for evening noise (i.e. 19.00-23.00);

  Lnight: is the A-weighted long-term average sound level, as defined by ISO 1996-2(1987), determined over all the night periods in a year. The definition of Lnight is the long-term LAeq over 8 hours outside at the most exposed facade. As Lnight is a relatively new definition and because the studies rarely cover such a long period, the research data are expressed in anything but Lnight.

- ENV.LOCAL.APT.PI 5: Noise footprint Area within the noise contours: (in Sq. Km).
- ENV.LOCAL.APT.PI 6: Affected Population: number of people in the vicinity of the airport included within the limits of the noise contour correspondent to:

  Lden > 55dB day;

  Lnight > 50dB night.

7.3.1.6 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.

7.3.2 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.

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

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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.

7.3.2.1 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.

7.3.2.2 Proposed Local PIs for TMA Environmental Sustainability

- ENV.LOCAL.TMA.PI 1: Total Fuel consumption (kg). Total fuel consumption, which is the sum of the fuel consumptions of all aircraft flying in the geographic area. Only the fuel burnt in during the scenario in its geographic area should be considered.
- ENV.LOCAL.TMA.PI 2: Affected Population (no unit). Number of people in the vicinity of the airport included within the limits of the Lden noise contour at 55dB. Lden is the Community noise equivalent Day-evening-night level. It is a descriptor of noise level based on energy equivalent noise level (Leq) over a whole day with a penalty of 10 dB(A) for night time noise (22.00-7.00) and an additional penalty of 5 dB(A) for evening noise *–i.e. 19.00-23.00.*
  - Noise Footprints / Noise Contours around the airport: provided as contours over the airport map in terms of:

    Lden: Community noise equivalent Day-evening-night level. It is a descriptor of noise level based on energy equivalent noise level (Leq) over a whole day with a penalty of 10 dB(A) for night time noise (22.00-7.00) and an additional penalty of 5 dB(A) for evening noise (i.e. 19.00-23.00);

    Lnight: is the A-weighted long-term average sound level, as defined by ISO 1996-2(1987), determined over all the night periods in a year. The definition of Lnight is the long-term LAeq over 8 hours outside at the most exposed facade. As Lnight is a relatively new definition and because the studies rarely cover such a long period, the research data are expressed in anything but Lnight.

Mean fuel consumption can be computed from *fuel consumption*. Note that fuels PIs are also relevant for Efficiency.

7.3.2.3 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.

7.3.2.4 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.

7.3.2.5 Proposed Local PIs for TMA Flexibility

- FLX.LOCAL.TMA.PI 1: BT 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).

7.3.2.6 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.

7.3.3 Local Performance Indicators for En Route

7.3.3.1 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.

7.3.3.2 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.

7.3.3.3 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).

7.3.3.4 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.

7.3.3.5 Proposed Local PIs for En Route Environmental Sustainability

- ENV.LOCAL.ER.PI 1: Actual Fuel consumption (kg). Total fuel consumption;
- ENV.LOCAL.ER.PI 2: Optimum Fuel consumption (kg). Total fuel consumption (no constraints in the airspace volume;
- ENV.LOCAL.ER.PI 3: Total emissions (kg). Especially CO2 emissions.

6.3.3.6 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: BT 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);
- 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).

8 CONCLUSIONS

This key document gives the starting point for the EP3 common reference on "WHAT" to measure" in order to obtain the 2020 ECAC wide performance of the SESAR's Operational Improvements. It describes the initial measurements that are going to be performed by the validation exercises and will evolve, adapt and further develop in the course of the EP3 project.

EP3 Performance Framework and SESAR are aligned through constant adoption of SESAR deliverables (see below) as they become available, there have been informal links between both programmes.

The Performance Framework WP 2.4.1 has also taken into account the D2 from SESAR, *Air Transport Framework – the Performance Target* but also the revised targets of the SESAR Performance objectives and Targets document. The influence diagrams developed in D3 deliverable*, Definition of the future ATM Target and in D4 deliverable, Selection of the "Best" Deployment Scenario* will be the basis used to build the relationships between the different layers of Performance Indicators and Key Performance Areas.

This framework will establish a methodology to integrate the results from the validation by developing a model that will be able to assess the ECAC performance of the SESAR concepts. The existence of a link (Influence Diagrams) between the different layers, PIs and OIs will be identified and the different methodologies proposed to assess those links will be based on a ECAC Model (section 6) supported by the:

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

Knowing the Operational Improvements that are going to be analysed by each exercise, Influence Diagrams giving cause-effect links between those Operational Improvements and Key Performance Areas are going to be developed by EP3 WP241. A risk has been identified due to the tight schedule, this risk is minimised by focusing on the Influence Diagrams in the OIs/sets of OIs identified by the exercises. More Influence Diagrams could be developed if time and effort enables it.

Furthermore, the Performance Framework has identified a pyramid of Performance Indicators layers and has motivated the experiments to select the highest layer for the integration of their results into the ECAC picture.

This integration of local PIs to ECAC PIs will be developed by WP241 in contact with the exercises. This coordination will take place along the year 2008 (see Annex IV. Planning).

If the exercises need to use metrics from outside of this catalogue, it will be asked to provide guidance for an integration process to feed the model.

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 and SESAR development phase.

9 GLOSSARY TERMS

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.
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, CO2 emission or delay.
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 PIs). 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.

Term	Definition
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.
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.
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.

10 ACRONYMS

ACC	Area Control Centre
AIS	Aeronautical Information System
ANS	Air Navigation System
ASM	Airspace Management
ATCO	Air Traffic Controller
ATFCM	Air Traffic Flow and Capacity Management
ATM	Air Traffic Management
BIC	Best in Class
CDA	Continuous Descendent Approach
CFIT	Controlled Flight Into Terrain
CONOPS	Concept of Operations
CNS	Communication Navigation Surveillance
EC	European Commission
ECAC	European Civil Aviation Conference
E-OCVM	European Operational Concept Validation Methodology
EP3	Episode 3
ERC	Eurocontrol Experimental Centre
ESARR	Eurocontrol Safety Regulation Requirements
GPM	Global Performance Manual
ICAO	Internationale Civil Aviation Organization
IFR	Instrumental Flight Rules
IMC	Instrumental Meteorological Conditions
ISBT	Initial Shared Business Trajectory
KPA	Key Performance Area
LoC	Lines of Change
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
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
TMA	Terminal and Manoeuvring Area
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions *

11 ANNEX I. LIST OF THE PERFORMANCE INDICATORS AND TRACEABILITY BETWEEN OI / OI STEPS AND ECAC PIS

11.1 LIST OF PERFORMANCE INDICATORS

This section shows an extract of the Capacity Performance Indicators spreadsheet that can be found in the referenced document [8] *EP3 WP241 Catalogue of PIs and Traceability OI Step vs ECAC PIs.xls*.

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.

11.2 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. For more information about the list of OI/OI Steps (see SESAR WP2.2.4 deliverable or the Excel file "EP3 WP2.4.1 Traceability - OI Step - PIs.xls") developed by EP3 WP2.4.1 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 the referenced document [8] *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		Capacity		Flexibility		Flexibility		Predictability
	The red colour means that the related OI Step has a **bad impact** in the associated ECAC PI							
	The yellow colour means that the related OI Step has a **positive but low impact** on the ECAC PI							
	The green colour means that the related OI Step has a **positive and high impact** on the ECAC PI							
	The white colour means that the related OI Step has **no impact** in the associated ECAC PI							

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
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12 ANNEX II. 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 the 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]							

13 ANNEX III. TABLE OF COMPLIANCE WITH THE VALIDATION REQUIREMENTS

13.1 REQUIREMENTS RELATING TO SESAR D2 PERFORMANCE FRAMEWORK AND TARGETS

The following Requirements are identified.

References	Validation Requirements	Compliance Justifications
VR-PF-1	The Performance Framework SHALL describe the KPA, KPI and Key Intermediate Metrics (KIM) which shall be used in Episode 3 to assess the ability of the SESAR Operational Concept to meet the 2020 performance targets.	See chapters 4.1 Key Performance Areas and their Targets and 7 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 4.1 Key Performance Areas and their Targets and 7 Catalogue of Performance indicators.
VR-PF-3	The Performance Framework SHALL cover all the operational segments considered for SESAR.	See chapters 1 Executive summary "The Episode 3 (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 11 Annex I. List of the performance indicators and traceability between oi / OI Steps and ECAC PIs.
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 4.1 Key Performance Areas and their Targets and 7 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 4.1 Key Performance Areas and their Targets and 7 Catalogue of Performance indicators. In addition the naming convention of the catalogue.

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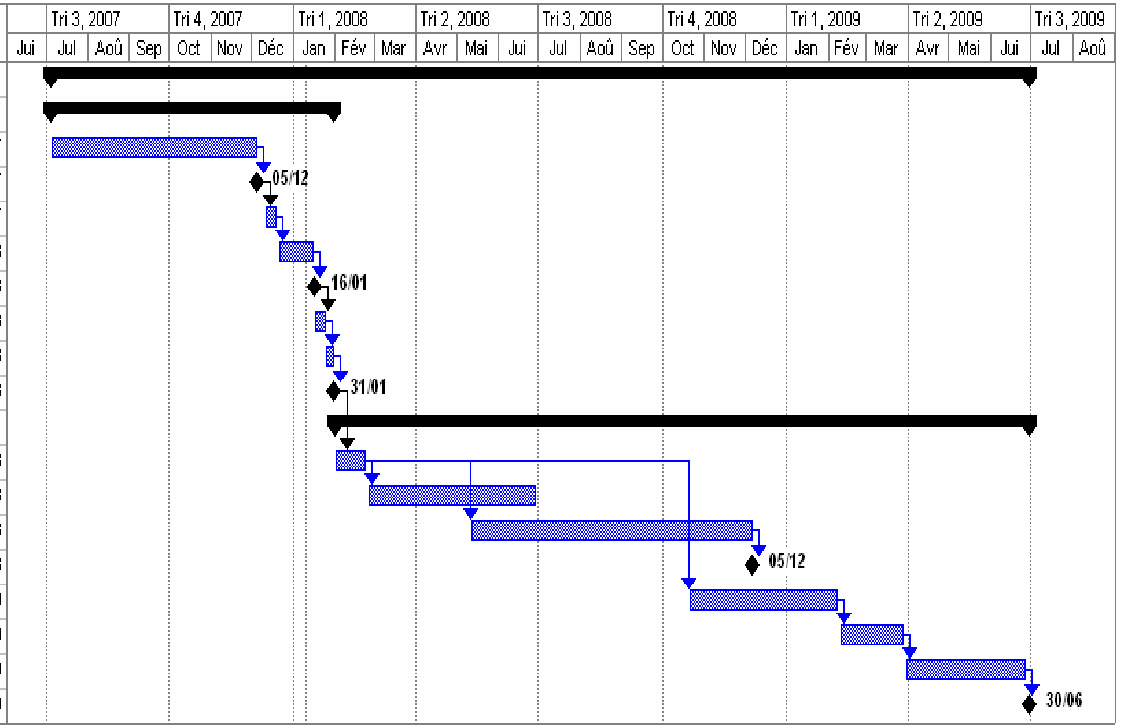
VR-PF-6	The Initial delivery of the Performance Framework SHALL include a catalogue of clearly defined Key Intermediate Metrics (KIM) which are considered appropriate to measure the performance of mechanisms contributing to the delivery of performance on the subject KPA & KPI. (This catalogue is to be 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 4.1 Key Performance Areas and their Targets and 7 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 4.1.2 Environmental Sustainability, 4.1.3 Safety. 4.1 Key Performance Areas and their Targets and 7 Catalogue of Performance indicators.

14 ANNEX IV. PLANNING

N°	Nom de la tâche	Début	Fin
17	**Performance Framework**	**Mer 04/07/07**	**Mar 30/06/09**
18	**Performance Framework construction**	**Mer 04/07/07**	**Jeu 31/01/08**
19	Development of the structure of the document (Influence model, methodology, etc...) -	Mer 04/07/07	Mar 04/12/07
20	Delivery to the project for comments of the performance Framework - Cycle 1	Mer 05/12/07	Mer 05/12/07
21	Cells & WP's Performance Framework comments	Mar 11/12/07	Mar 18/12/07
22	Improvement of the Peformance Framework - cycle 1	Ven 21/12/07	Mar 15/01/08
23	Delivery to the project for comments of the performance Framework - Cycle 1	Mer 16/01/08	Mer 16/01/08
24	Cells & WP's Performance Framework comments	Jeu 17/01/08	Jeu 24/01/08
25	Improvement of the Peformance Framework - cycle 1	Ven 25/01/08	Mer 30/01/08
26	Delivery to the European commission of the performance Framework - Cycle 1	Jeu 31/01/08	Jeu 31/01/08
27	**Performance Methodology, Model development and ECAC assessment**	**Ven 01/02/08**	**Mar 30/06/09**
28	Review and consistency of existing Influence Model Cycle 1	Ven 01/02/08	Ven 22/02/08
29	Development the Influence Model Cycle 1	Lun 25/02/08	Ven 27/06/08
30	Development of the methodology Cycle 1	Lun 12/05/08	Ven 05/12/08
31	Internal delivery to the Project of the updated performance Framework - Cycle 1	Ven 05/12/08	Ven 05/12/08
32	Development of the ECAC model cycle 1	Lun 20/10/08	Ven 06/02/09
33	Performance Assessment (Model) - Cycle 1	Lun 09/02/09	Ven 27/03/09
34	Performance analysis and reporting - Cycle 1	Lun 30/03/09	Ven 26/06/09
35	Delivery to the European Commission of the Performance Framework Delivery - Cycle	Mar 30/06/09	Mar 30/06/09



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