C/CAR/DCA/10 – WP/13
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International Civil Aviation Organization
North American, Central American and Caribbean Office (NACC)
Tenth Meeting of Directors of Civil Aviation of the Central Caribbean (C/CAR/DCA/10)
Grand Cayman, Cayman Islands, 18 to 21 August 2009

Agenda Item 6: Air Navigation Matters
6.2 Global and Regional Performance Based Air Navigation Implementation Plans

AIR NAVIGATION PERFORMANCE MONITORING AND MEASUREMENT

(Presented by the Secretariat)

SUMMARY

One of the key aspects of the performance based approach to air navigation planning is the development of performance objectives with related measurable indicators and metrics. This paper proposes an initial set of key performance areas and associated metrics to be used as the basis for performance measurement of the regional air navigation work programme.

Action by the meeting is in paragraph 7.

References:

- GREPECAS 15/ WP37 and GREPECAS/15 Report
- Global Air Traffic Management Operational Concept (Doc 9854)
- Manual on Global Performance of the Air Navigation System (Doc 9883); and
- Global Air Navigation Plan (Doc 9750)

Strategic Objectives	*This working paper is related to Strategic Objectives A, C, D and E.*

1. Introduction

1.1 *Air Navigation Planning process*: The ICAO planning objective is to achieve a performance based global air traffic management (ATM) system through the implementation of air navigation systems and procedures in a progressive, cost-effective and cooperative manner. The regional planning and implementation process is the principal engine of ICAO's planning framework. It is here that the top-down approach comprising global guidance and regional harmonization measures converge with the bottom-up approach constituted by national planning by States.

2. Transition to a Performance Based Air Navigation Planning

2.1 *Basis*: The notion of a performance based air navigation system emanated from good industry practices that have emerged over many years. As the aviation industry evolved into a less regulated and more corporatized environment with greater accountabilities, the advantages of transitioning from systems based to performance-based planning are apparent.

2.2 *Principles:* The performance-based approach (PBA) adheres to the following principles: strong focus on results through adoption of performance objectives and targets; collaborative decision making driven by the results; and reliance on facts and data for decision making. In PBA methodology the assessment of achievements is periodically checked through a performance review, which in turn requires adequate performance measurement and data collection capabilities.

2.3 *Advantages*: The advantages of PBA methodology include: Result oriented, transparent and promotes accountability; shift from prescribing solutions to specifying desired performance; employs quantitative and qualitative methods; avoids a technology driven approach; helps decision makers to set priorities, makes the most appropriate trade-offs, and allows optimum resource allocation.

2.4 *Guidance:* To facilitate the realization of a performance based Global ATM system, ICAO has made significant progress in the development of relevant guidance material. The documents include: a) Global Air Traffic Management Operational Concept (Doc 9854); b) Air Traffic Management System Requirements (Doc 9882); c) Manual on Global Performance of the Air Navigation System (Doc 9883); and d) Global Air Navigation Plan (Doc 9750).

3. Regional and National Performance Planning for Air Navigation Systems

3.1 *Outcome of GREPECAS/15*: The GREPECAS/15 meeting held in Rio de Janeiro, Brazil from 13 to 17 October 2008, while adopting a regional performance framework (Conclusion 15/1 refers), invited States to adopt a national performance framework on the basis of ICAO guidance material and aligned with the regional performance objectives, the regional air navigation plan and the Global ATM Operational Concept. The performance framework should include identification of national performance objectives taking into consideration user expectations and completion of national performance framework forms (**Appendix A** to this WP refers) for all air navigation areas.

3.2 *Regional workshops*: As a follow-up to the GREPECAS 15/1 Conclusion, the Secretary General, in January 2009, established a SIP consisting of two workshops, one for the States of the South American and another for the NAM/CAR Regions in order to provide requisite training in the development of national air navigation performance framework. The workshops were held from 13 to 17 April 2009 in Lima, Peru and from 6 to 10 July 2009 in Mexico City, Mexico.

4. Air Navigation Performance Monitoring and Measurement

4.1 *Data management*: Data collection, processing, storage and reporting are fundamental to the performance-based approach and form part of performance monitoring and management. It should not be assumed that all data which is needed is simply available "somewhere" and only needs to be copied. Although re-use of data prepared by others is sometimes possible, the data reporting chain always starts at the "grass-roots level", and properly setting up and managing the entire chain is an integral part of the approach. Establishing a data reporting chain usually involves participation from many ATM community members. Their willingness to participate requires the establishment of a performance data reporting culture, a capability to successfully manage disclosure and confidentiality aspects, and deciding on a case-by-case basis which approach works best: mandatory or voluntary reporting. In the end, data will be condensed into a few indicators which represent the high level knowledge about the performance of the system.

4.2 *Terminology*: It is essential to use harmonized terminology in applying performance based approach to planning and implementation of air navigation systems. For performance measurement three basic terms are explained. a) *Performance Indicator:* Current/past performance, expected future performance as well as actual progress in achieving performance objectives is quantitatively expressed by means of performance indicators (sometimes called Key Performance Indicators, or KPIs). To be relevant, indicators need to correctly express the intention of the associated performance objective. Since indicators support objectives, they should not be defined without having a specific performance objective in mind. These performance 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); b) *Performance target*: 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; and c) *Metrics:* 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). Supporting metrics fulfil three functions. They form a basis for assessing and monitoring the provision of ATM services, they define what ATM services users value and they can provide common criteria for cost benefit analysis for air navigation systems development. These metrics are used to calculate the values of performance indicators. In other words, metrics are quantitative measure of system performance – how well the system is functioning.

5. Choosing Metrics for CAR/SAM Regions

5.1 *Methodology*: The increased demand for ATS services has begun to focus attention on the performance rather than capabilities of technologies. As the investment decisions required for providing ATM services become more complex, the need for well defined metrics for ATM systems performance increases. A structured methodology for the decomposition of key performance areas into performance indicators, targets and metrics is illustrated in the figure in **Appendix B** hereto.

5.2 *Metrics:* The performance monitoring and measurement of ATM systems calls for metrics in area that envelopes access, capacity, cost effectiveness, efficiency, environment, flexibility, predictability and safety. On the basis of the Global ATM Operational Concept and the Manual on Performance of the Global Air Navigation System, a sample set of metrics is listed in **Appendix C** to this working paper. It should be noted that the list in Appendix C hereto is not exhaustive. The region/subregion, on the basis of its experience, could determine the appropriate metrics applicable to its situation. Agreement on the metrics would necessitate common definitions and understanding.

5.3 *ICAO Statistics Programme*: It is noteworthy that the data needed for some of the metrics (e.g. fuel consumption or aircraft movements) listed in Appendix C are in the final phase of being officially collected from the Contracting States, in the context of the ICAO Statistics Programme, managed by the Economic Analyses and Databases (EAD) section at ICAO Headquarters, Montreal.

6. Conclusion

6.1 *Evolutionary approach:* The global ATM system will emerge through the implementation of many initiatives over several years on an evolutionary basis. At first, the planning and implementation activities begin with application of available procedures, processes and capabilities. The evolution progresses to the application of emerging procedures, processes and capabilities and ultimately, migrates to the ATM system based on the operational concept.

6.2 *Recommendation:* Considering the need to have a clearly defined common approach to performance monitoring and measurement and the need to agree on a uniform set of metrics, the meeting is invited to adopt the following conclusion:

Draft Conclusion 10/x AIR NAVIGATION PERFORMANCE MONITORING AND MEASUREMENT

That:

a) the C/CAR/WG agree on a set of metrics related to key performance areas of access, capacity, cost effectiveness, efficiency, environment, flexibility, predictability and safety by the 8th meeting to be held in 2010;

b) the C/CAR States/Territories incorporate these agreed metrics into the performance monitoring process by the end of 2010, collect relevant data and submit to the ICAO NACC Regional Office on a regular basis; and

c) the C/CAR States/Territories coordinate with the ATM community members to promote information and data collection.

7. Action by the Meeting

7.1 The Meeting is invited to approve the draft conclusion at paragraph 6.2 above.

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APPENDIX A

PERFORMANCE FRAMEWORK FORM
(for illustration purpose only)

<table>
<tr><td colspan="5">STRATEGIC OPERATIONAL IMPROVEMENT
REGIONAL PERFORMANCE OBJECTIVES /NATIONAL PERFORMANCE OBJECTIVES

OPTIMIZE THE ATS ROUTE STRUCTURE IN EN-ROUTE AIRSPACE</td></tr>
<tr><td colspan="5">Benefits</td></tr>
<tr><td>Environment
Efficiency</td><td colspan="4">• reductions in fuel consumption;
• ability of aircraft to conduct flight more closely to preferred trajectories;
• increase in airspace capacity;
• facilitate utilization of advanced technologies (e.g., FMS based arrivals) and ATC decision support tools (e.g., metering and sequencing), thereby increasing efficiency.</td></tr>
<tr><td>Metrics</td><td colspan="4">Measurement
i. Procedure design course conducted
ii. Number PBN routes implemented
iii. CO_2 reduction of new routes
iv. Number of ATC automated systems that are interconnected</td></tr>
<tr><td colspan="5">Strategy
Short term (2010)
Medium term (2011 - 20015)</td></tr>
<tr><td>ATM OC COMPONENTS</td><td>PROJECTS/TASKS</td><td>TIMEFRAME START-END</td><td>RESPONSIBILITY</td><td>STATUS</td></tr>
<tr><td>AOM</td><td>• Formulate airspace concept and determine requirements
• analyze the en-route ATS route structure and implement all identifiable improvements;
• implement all remaining regional requirements (e.g. RNP 10 routes); and
• finalize implementation of WGS-84
• monitor implementation progress
• develop a strategy and work programme to design and implement a trunk route network, connecting major city pairs in the upper airspace and for transit to/from aerodromes, on the basis of PBN and, in particular, RNAV/5, taking into account interregional harmonization;
• monitor implementation progress</td><td></td><td></td><td></td></tr>
<tr><td>Link to GPIs</td><td colspan="4">GPI/5: performance-based navigation, GPI/7: dynamic and flexible ATS route management, GPI/8: collaborative airspace design and management, GPI/11: RNP and RNAV SIDs and STARs and GPI/12: FMS-based arrival procedures.</td></tr>
</table>

PERFORMANCE FRAMEWORK FORM - EXPLANATORY NOTES

1. **Performance framework form:** This form is an output and management form which is applicable to both regional and national planning and includes references to the Global Plan. Other formats may be appropriate but should contain as a minimum the elements described below

2. **Performance objective/Strategic operational improvement:** Regional /national performance objectives should be developed using a performance based approach that best reflects the necessary activities needed to support regional/national ATM systems. During their life cycle, performance objectives may change depending on the ATM system's evolution; therefore, throughout the implementation process, these should be coordinated with and be available to all interested parties within the ATM Community. The establishment of collaborative decision making processes ensures that all stakeholders are involved in and concur with the requirements, tasks and timelines.

3. **Regional performance objective:** Regional performance objectives are the improvements required to the air navigation system in support of the global performance objectives, and are related to the operating environments and priorities applicable at the regional level.

4**.** **National performance objective:** National performance objectives are the improvements required to the air navigation system in support of the regional performance objectives, and are related to the operating environments and priorities applicable at the State level.

5**.** **Benefits:** The regional/national performance objectives should meet the expectations of the ATM community as described in the operational concept and should lead to benefits for stakeholders and be achieved through operational and technical activities aligned with each performance objective.

6. **Metrics:** The performance monitoring and measurement of ATM systems calls for metrics in area that envelopes access, capacity, cost effectiveness, efficiency, environment, flexibility, predictability and safety. The metrics form a basis for assessing and monitoring the provision of ATM services, they define what ATM services user value and they can provide common criteria for cost benefit analysis for air navigation systems development. Metrics are quantitative measure of system performance – how well the system is functioning

7. **Strategy:** ATM evolution requires a clearly defined progressive strategy including tasks and activities which best represent the national and regional planning processes in accordance with the global planning framework. The goal is to achieve a harmonized implementation process evolving toward a seamless global ATM system. For this reason, it is necessary to develop short (1 to 5 years) and medium term (6 to 10 years) work programmes, focusing on improvements to the system indicating a clear work commitment for the parties involved.

8. **ATM operational concept components;** Each strategy or set of tasks should be linked with associated components of the ATM operational concept. The designators for ATM components are as follows:

- AOM – Airspace organization and management
- DCB – Demand and capacity balancing
- AO – Aerodrome operations
- TS – Traffic synchronization
- CM – Conflict management
- AUO – Airspace user operations
- ATM SDM – ATM service delivery management

9. **Projects/Tasks:** The regional/ national work programmes, using this PFF template, should define projects/tasks in order to achieve the said performance objective and at the same time maintain a direct relation with ATM system components. The following principles should be considered when developing a work programme:

- The work should be organized using project management techniques and performance-based objectives in alignment with the strategic objectives of ICAO.

- All projects/tasks involved in meeting the performance objectives should be developed using strategies, concepts, action plans and roadmaps which can be shared among parties with the fundamental objective of achieving seamlessness through interoperability and harmonization.

- The planning of projects/tasks should include optimizing human resources as well as encouraging dynamic use of electronic communication between parties such as the Internet, videoconferences, teleconferences, e-mail, telephone and facsimile. Additionally, resources should be efficiently used, avoiding any duplication or unnecessary work.

- The work process and methods should ensure that performance objectives can be measured against timelines and the national and regional progress achieved can be easily reported to PIRGs and ICAO Headquarters respectively.

10. **Timeframe:** Indicates start and end time period of that particular project(s)/task(s).

11. **Responsibility:** Indicates the organization/entity/person accountable for the execution or management of the related tasks.

12**.** **Status:** The status is mainly focused on monitoring the progress of the implementation of that task(s) as it progresses toward the completion date.

13. **Link to global plan initiatives(GPIs)*:*** The 23 GPIs, as described in the Global Plan, provide a global strategic framework for planning for air navigation systems and are designed to contribute to achieving the regional/national performance objectives. Each performance objective should be mapped to the corresponding GPIs. The goal is to ensure that the evolutionary work process at the State and regional levels will be integrated into the global planning framework.

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APPENDIX B

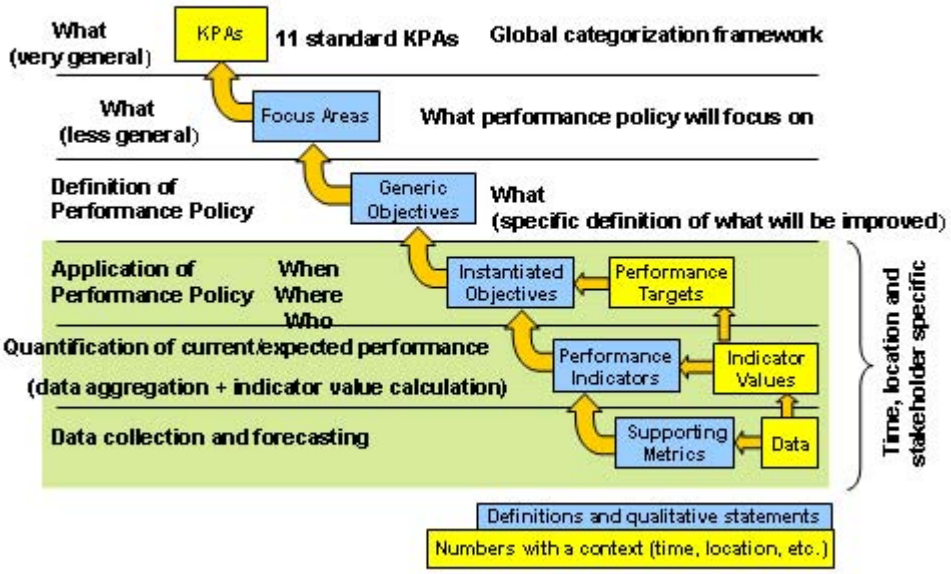

Figure: Illustration of Measurement Taxonomy

Extracted from the Manual on Global Performance of the Air Navigation System (Doc 9883)

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APPENDIX C

A sample list of metrics for performance monitoring of air navigation systems

Key Performance Area	Corresponding metrics
1. Access and equity	Civil flights using fixed airspace; Unusable airspace due to navigation restriction; Number of access denials; Number of airports with published approaches.
2. Capacity	Average daily airport capacity for a group of 35 airports measured as a 5 year moving average; Hourly number of IFR movements (departure + arrivals) during IMC; Total number of operations per day; Number of aircraft in a specified volume of airspace; Airspace throughput/TMA-number of aircraft per 100nmi3; Traffic density i.e. number of aircraft per 100 nmi3; Enroute utilization i.e. number of aircraft per 100nmi3; Airside Capacity i.e. number of operations per hour; Airborne delay i.e. minutes per flight; Arrival/departure delay i.e. minutes per flight.
3. Cost effectiveness	Total operating cost plus cost of capital divided by IFR flights; Average cost per flight at a system wide annual level;. Investment cost; Cost per retrofit; Out of service cost; Operating and Maintenance cost.

Key Performance Area	Corresponding metrics
4. Efficiency	Estimated fuel savings (year 2000 as baseline); Percent of flights departing on-time; Percentage of instrument runway ends with an approach procedure with vertical guidance (APV), (BARO-VNAV and/or augmented GNSS) either as the primary approach or as a back-up for precision approaches; PBN Routes implemented and published in enroute; Number of certified aircraft and pilots for PBN operations for enroute and TMA; Percent of flights with normal flight duration; Traffic movements i.e. # of movements; Unused capacity i.e. # of movements; Number of ATC automated systems that are interconnected; Number of terminal areas with SID/STAR implemented.
5. Environment	Amount of emissions which are attributable to inefficiencies in ATM service provision; Pounds of fuel burn per operation; Local noise foot print; Number of noise complaints.
6. Flexibility	Proportion of rejected changes for which an alternative was offered and taken; Enroute flight distance Percentage of flights off-on ATC preferred routes; Number of backups available for emergency; Flexibility in sequencing; Number of restrictions.
7. Predictability	Variability in delay for arrival time./departure time/enroute and Taxi time i.e. Minutes /flight; Number of aircraft held i.e. # Aircraft /hr; Number of cancellations/diversions/misconnections i.e. #of flights ;
8. Safety	Number of runway incursions per year; Number of operational errors per year; Number of accidents per 100,000 departures; Number of fatalities per 100,000 departures; Number of LHD reports.