International Civil Aviation Organization
Eastern and Southern African Office

Thirteenth Meeting of the Air Traffic Management/Aeronautical Information Management/Search and Rescue Sub-Group (ATM/AIM/SAR SG/13)
(Nairobi, Kenya, 16 - 19 September 2013)

Agenda Item 6: Performance-Based Navigation (PBN) and AFI ATS Route Network

OPTIMISED ROUTE TRAJECTORIES

(Presented by the Secretariat)

SUMMARY

This paper discusses the development of ATS route trajectories as part of implementation of the APIRG plan in establishing the PRND Working Group. It highlights the issues related to the comprehensive review of the AFI ATS route network, airspace optimization in general in the context of the ASBUs methodology, and report on the outcome of the PRND WG/3 meeting, Dakar 5-8 August 2013.

Action by the meeting is at **paragraph 3.**

REFERENCES

- APIRG 18 Meeting Report
- AN-Conf/12 Report
- Fourth Edition of the GANP (Doc 9750)

This Working Paper is related to Strategic Objectives: **A and C**

1. INTRODUCTION AND BACKGROUND

APIRG-Regional planning

1.1 The meeting will recall that the APIRG 18 meeting in Kampala, Uganda (27-30 March 2012) highlighted that users (represented by IATA) were expected to provide a comprehensive user statement of requirements reflecting user preferred trajectories at the level of the whole of the AFI Region. This was to enable the PRND Working Group to undertake a comprehensive review and update of the AFI ATS route network towards the goal of an efficient Regional network as opposed to efficiencies at micro levels. The APIRG 18 meeting in 2012 adopted Conclusion 18/12 as follows:

CONCLUSION 18/12: AFI ATS ROUTE CATALOGUE TEMPLATE

That, in order to support the process of ATS route development in the AFI Region, including the keeping of a record of ATS routes proposed for development and

facilitating follow- up on the actions pertaining to the routes' development:

a) the AFI ATS Route Catalogue (AARC template) is adopted as at Appendix 3.2C to the report on agenda item 3.2; and

b) AFI States and concerned international organizations are urged to periodically review the Catalogue once completed, note developments and take action as applicable.

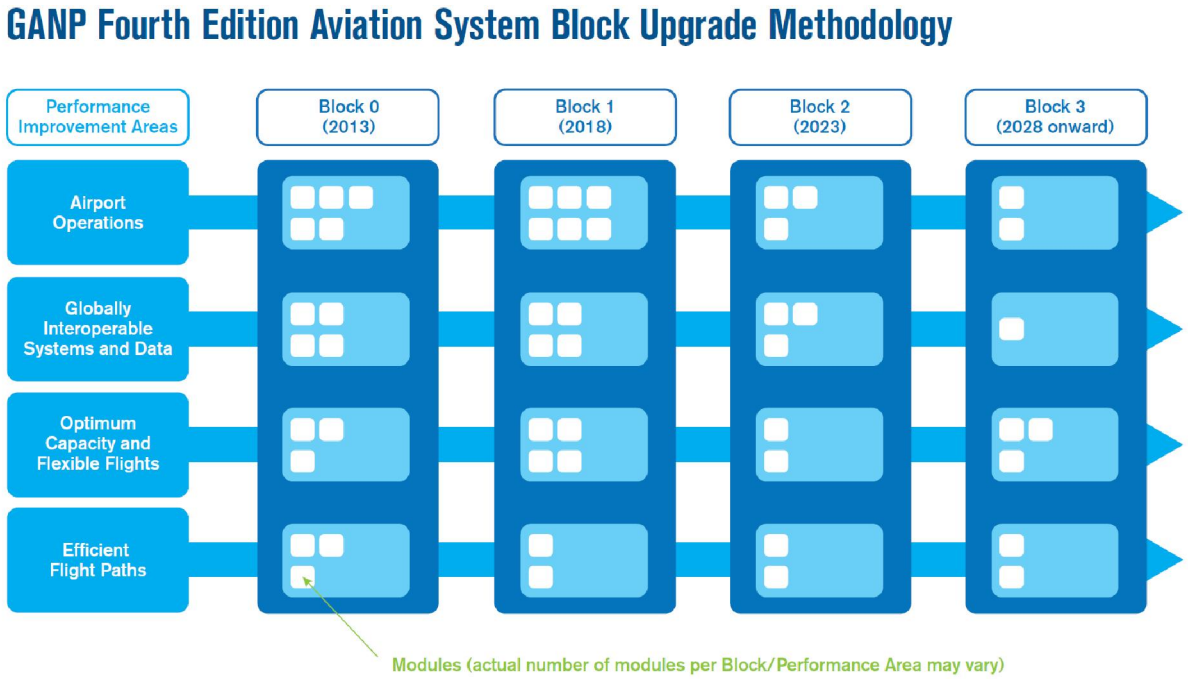
1.2 The purpose of the AARC is to contain a list of ATS route proposals that have been agreed within the framework of APIRG for further consideration and processing, in the near to long term, until such ATS route proposals have been processed as amendments to the AFI ANP (Doc 7474) Table ATS-1 and approved by the ICAO Council, whence they will be removed from the AARC. Other ATS route proposals agreed to be removed from the AARC will be for such reasons as being improbable, overtaken by events, or replaced by an agreed alternative. The AARC will be used to record and track the routes' development, and will as such be a living document updated at relevant meetings and by the Secretariat, within the APIRG framework. It shall not be the purpose or intention of the AARC to duplicate the ANP Table ATS-1 or its purpose.

Global guidance

1.3 In Montréal, 19 to 30 November 2012 the Twelfth Air Navigation Conference (AN-Conf/12) adopted Recommendation 1/1 introducing the revised draft Fourth Edition of the Global Air Navigation Plan (Doc 9750, GANP). In addition to building on the past editions of the GANP, the new GANP identifies the need for the development of standards and recommended practices, regulatory requirements, procedures and technology associated with the aviation system block upgrades (ASBU) methodology

1.4 The Block Upgrades incorporate a long-term perspective matching that of the three companion ICAO Air Navigation planning documents: *Global Air Traffic Management Operational Concept (GATMOC) (Doc 9854), Manual on Air Traffic Management System Requirements (Doc 9882)* and the *Manual on Global Performance of the Air Navigation System (Doc 9883)*. They coordinate clear aircraft- and ground-based operational objectives together with the avionics, data link and ATM system requirements needed to achieve them. The overall strategy serves to provide industry-wide transparency and essential investment certainty for operators, equipment manufacturers and ANSPs. The core of the Block Upgrade concept is linked to four specific and interrelated aviation performance areas.

1. Airport operations.
2. Globally-interoperable systems and data
3. Optimum capacity and flexible flights
4. Efficient flight paths



The ICAO Block Upgrades (blue columns) refer to the target availability timelines for a group of operational improvements (technologies and procedures) that will eventually realize a fully-harmonized global Air Navigation System. The technologies and procedures for each Block have been organized into unique 'Modules' (smaller white squares) which have been determined and cross-referenced based on the specific Performance Improvement Area they relate to. ICAO has produced the systems engineering for its Member States so that they need only consider and adopt the Modules appropriate to their operational need.

1.5 Block 0 of the ASBUs, which spans 2013 to 2017 features Modules characterized by technologies and capabilities which have already been developed and implemented in many parts of the world today. PBN is a major component of Block 0 and is ICAOs highest priority in air navigation.

1.6 Although they introduce a new planning framework with increased definition and broad timelines, the Fourth Ed. Global Plan's Block Upgrades are consistent with the Third Edition of the GANP's planning process encompassing near-term, mid-term and long-term global plan initiatives (GPIs). This consistency has been retained to ensure the smooth transition from the former planning methodology to the Block Upgrade approach. One of the clear distinctions between the Third Edition Global Plan and new Fourth Edition Global Plan is that the consensus-driven Block Upgrade methodology now provides more precise timelines and performance metrics. This permits the alignment of planning on concrete, shared operational improvements that are referenced to the third edition of the GPIs in order to preserve planning continuity.

2. DISCUSSION

Air Navigation Plans

2.1 To advance the access to the operational benefits, particularly those related to the much sought safety improvements and some of the low-hanging fruits, in 2007 the ICAO Assembly adopted Resolution A36-23 subsequently amended by A37-11 relating to PBN global implementation goals. The following GPIs from the 3rd Ed. GANP, which are duly

reflected in the 4th Ed. are implicated in PBN:

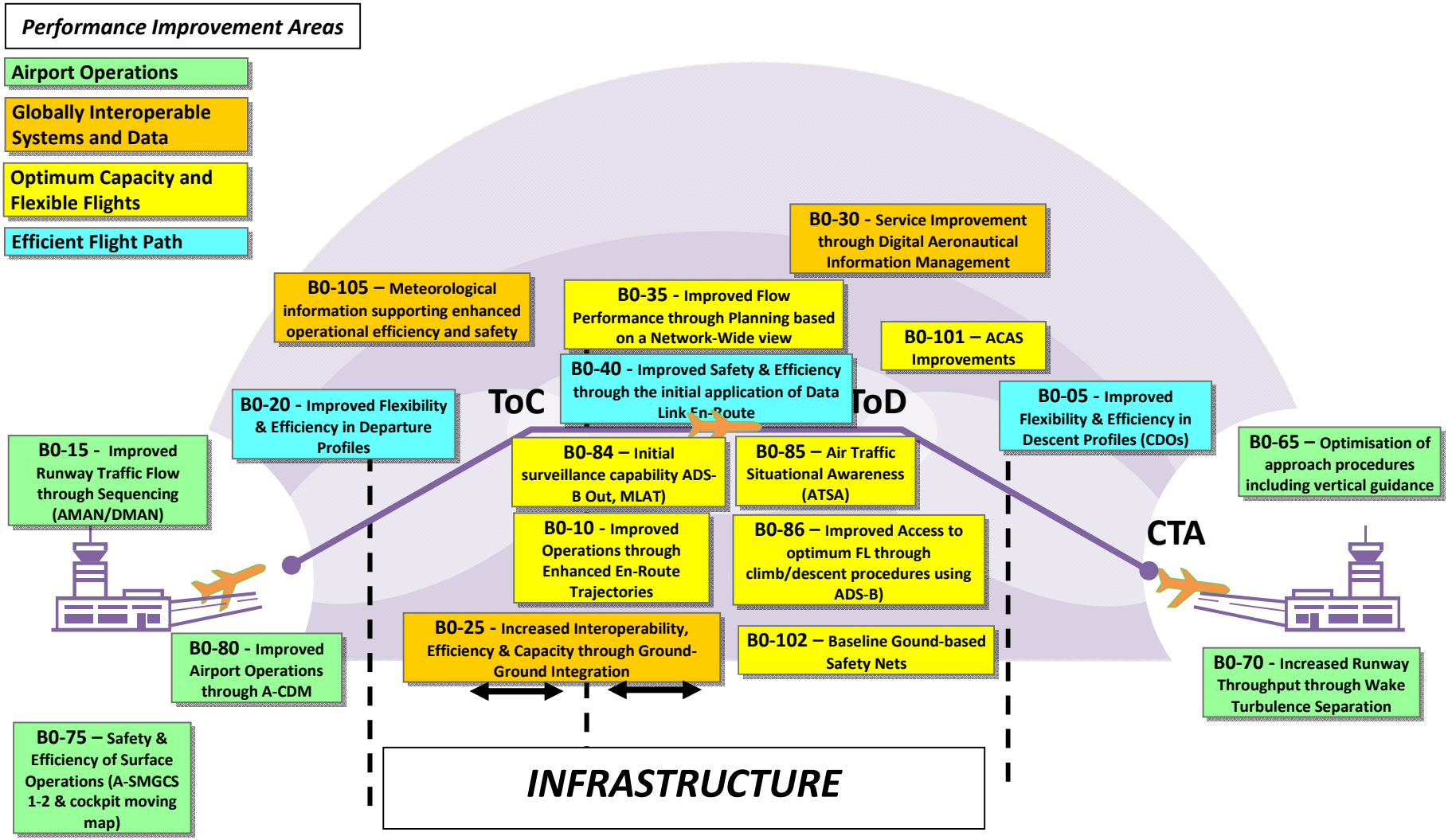
GPI-5: performance-based navigation;
GPI-7: dynamic and flexible ATS route management;
GPI-8: collaborative airspace design and management;
GPI-10: terminal area design and management;
GPI-11: RNP and RNAV SIDs and STARs; and
GPI-12: Functional integration of ground systems with airborne systems

2.2 The following table shows the airspace optimization performance objectives which were implemented under the framework of the PBN/GNSS Task Force, and the associated ASBUs modules:

3rd Ed. GANP PBN related Performance Objectives and Performance Framework Forms (PFFs)	ASBUs (4th Ed. GANP) Performance Improvement areas (PIA) & immediate modules & Air Navigation Reporting Forms (ANRFs)
Optimization of vertically guided approaches	PIA1
Optimization of the ATS Route Structure - Terminal	PIA 3, PIA 4
Optimization of the ATS Route Structure - En-Route	**PIA 3**: **B0-FRTO (B0-10)**: Improved Operations through Enhanced En-Route Trajectories **B0-NOPS (B0-35)**: Improved Flow Performance through Planning based on a Network-Wide view **PIA 4:** **B0-TBO (B0-40):** Improved Safety and Efficiency through the initial application of Data Link En-Route

BLOCK 0 PERSPECTIVE

Note: New module names have been adopted in the 4th Ed. of Doc 9750. e.g. B0-10 is now B0-FRTO



2.3 The meeting may wish note that despite a number of implementation challenges, PBN, as an enabler of the ATM Operational Concept has gained considerable familiarity in States/ANSPs. In about two years, between 2010 and 2013, more than 80 ATS route trajectories based on PBN were agreed (between States/Users/ICAO) as facilitated by the IATA Route Labs, iFLEX initiatives, ATM Coordination Meetings and other complementary initiatives. Close to 80% of the trajectories have been implemented. Significant progress has also been achieved in the terminal area, particularly in the approach phase; thanks to the support of IATA and industry stakeholder.

2.4 Notwithstanding the progress made, there remains considerable room for operational improvements that can yield significant efficiencies and contribution to environmental protection. Moreover, while some States will be able to meet the 2016 global implementation goals established in Assembly Resolution A37-11, the observed rate of implementation of PBN currently indicates that this target is unlikely to be achieved in the AFI Region. While progress can be achieved with minimal external coordination in the terminal airspace, for States to meet their obligations with regard to ATS routes that constitute regional requirements, coordination between several States/FIRs at a time is necessary; hence the role of APIRG and its subsidiary bodies and ICAO Regional Offices.

2.5 While the primary focus of the PRND WG is the en-route phases of operations, it nevertheless is important to take due cognizance of other phases of operations forming part of the ASBUs. From the Block 0 modules summarised herein, it will be noted that the focus of the PRND WG is **B0-FRTO (B0-10)**. However, the implementation of this module is supported by several others.

> ***B0-FRTO (B0-10): Improved Operations through Enhanced En-Route Trajectories***
>
> *Implementation of performance-based navigation (PBN concept) and flex tracking to avoid significant weather and to offer greater fuel efficiency, flexible use of airspace (FUA) through special activity airspace allocation, airspace planning and time-based metering, and collaborative decision-making (CDM) for en-route airspace with increased information exchange among ATM stakeholders*
> ASBU TEMPLATE

AORTA

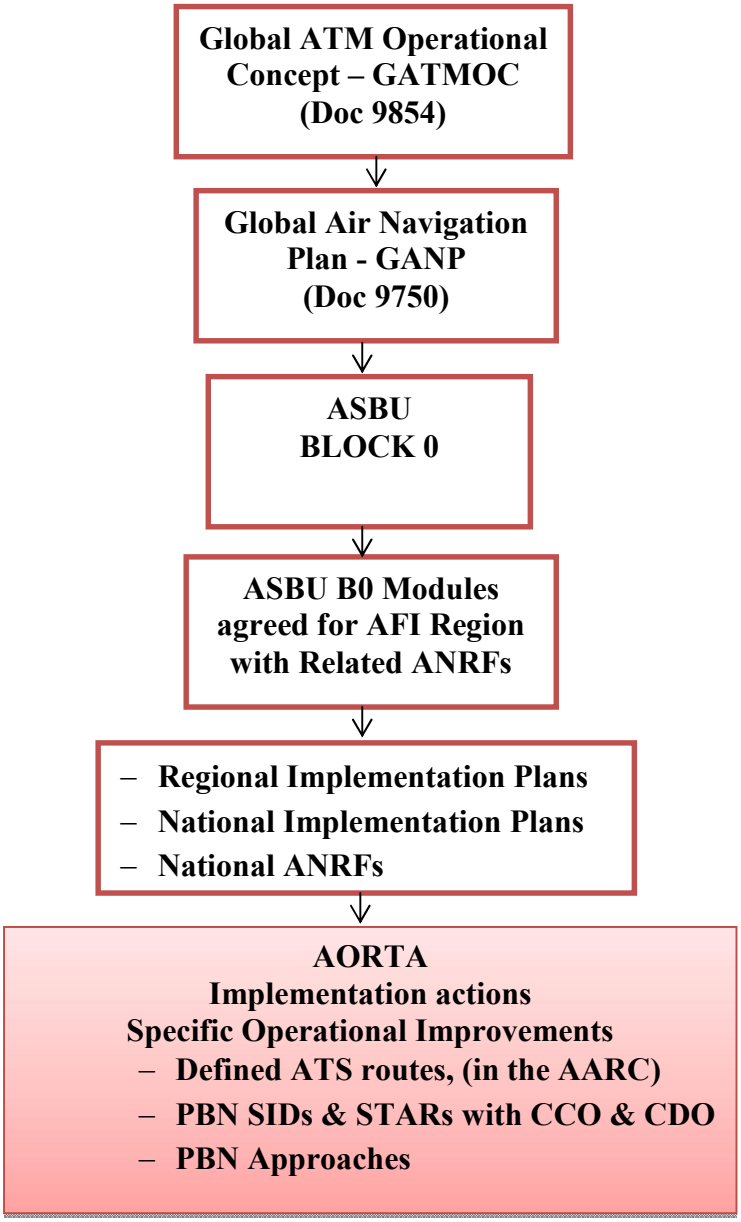
2.6 In order to provide for a coordinated development, the AFI Optimised Route Trajectories and Airspace (AORTA) is introduced to provide for the identification of specific elements of implementation carried over from the work done under the 3rd Ed of the GANP and the Regional Performance objectives to the 4th Ed. In this regard, AORTA is a package of specific end to end (departure to arrival) improvements which will be phased for implementation at specific targets on a Regional (AFI) basis. As such AORTA consists of the following:

a) Regional ATS routes (en-route structure) – Developed under agreement to form part of the ANP as regional requirements

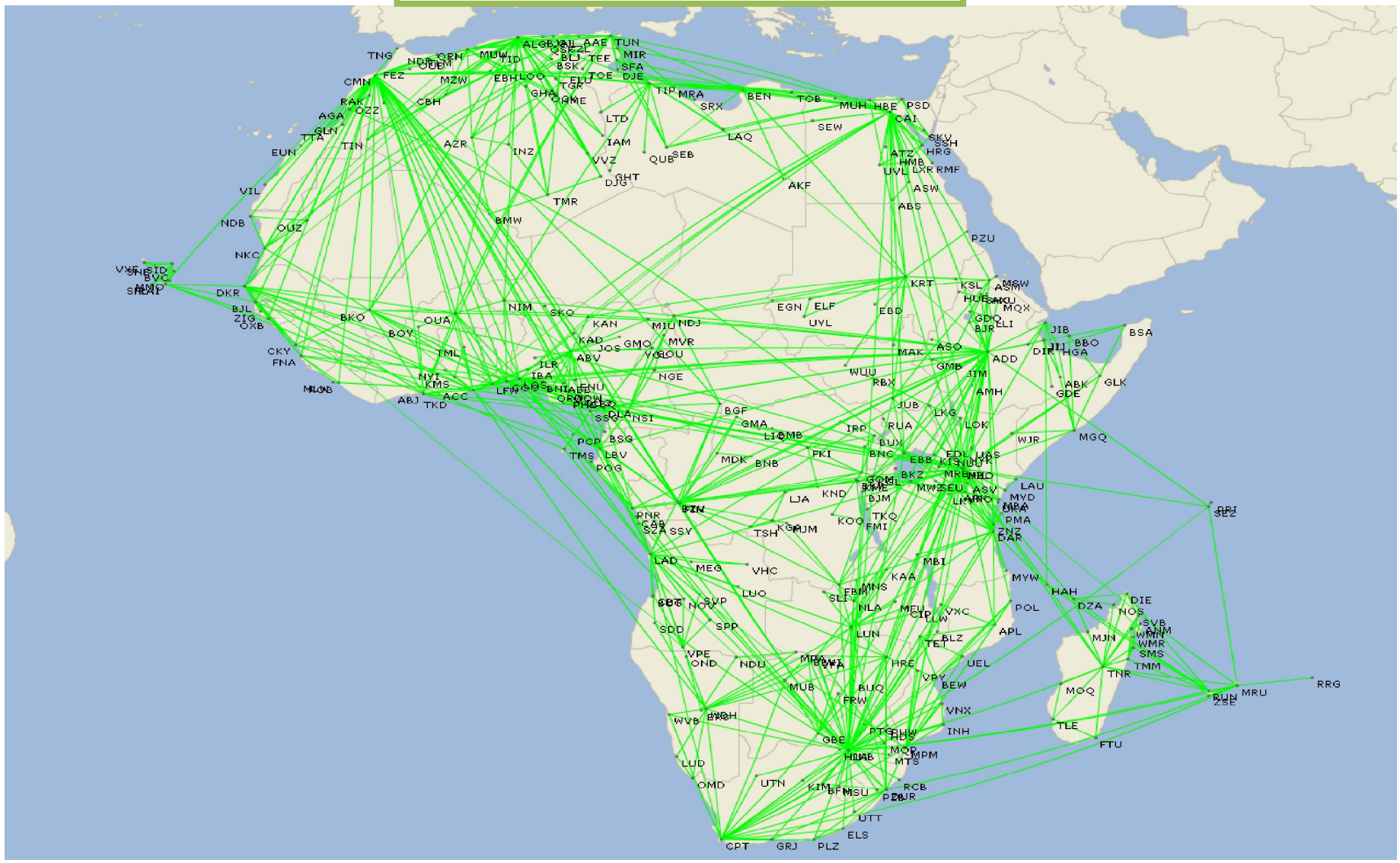
b) Terminal routes (PBN-based SIDs/STARs) – developed by States/ANSPs in coordination with adjacent airspaces as necessary, intended to specifically transition to/from the optimized en-route structure
c) PBN Instrument approach procedures

2.7 In order to arrive at the specific elements (routes, etc.) forming part of AORTA, States will continue to be guided by the **Regional PBN Implementation Plan** as updated and aligned within the framework of the ASBUs.

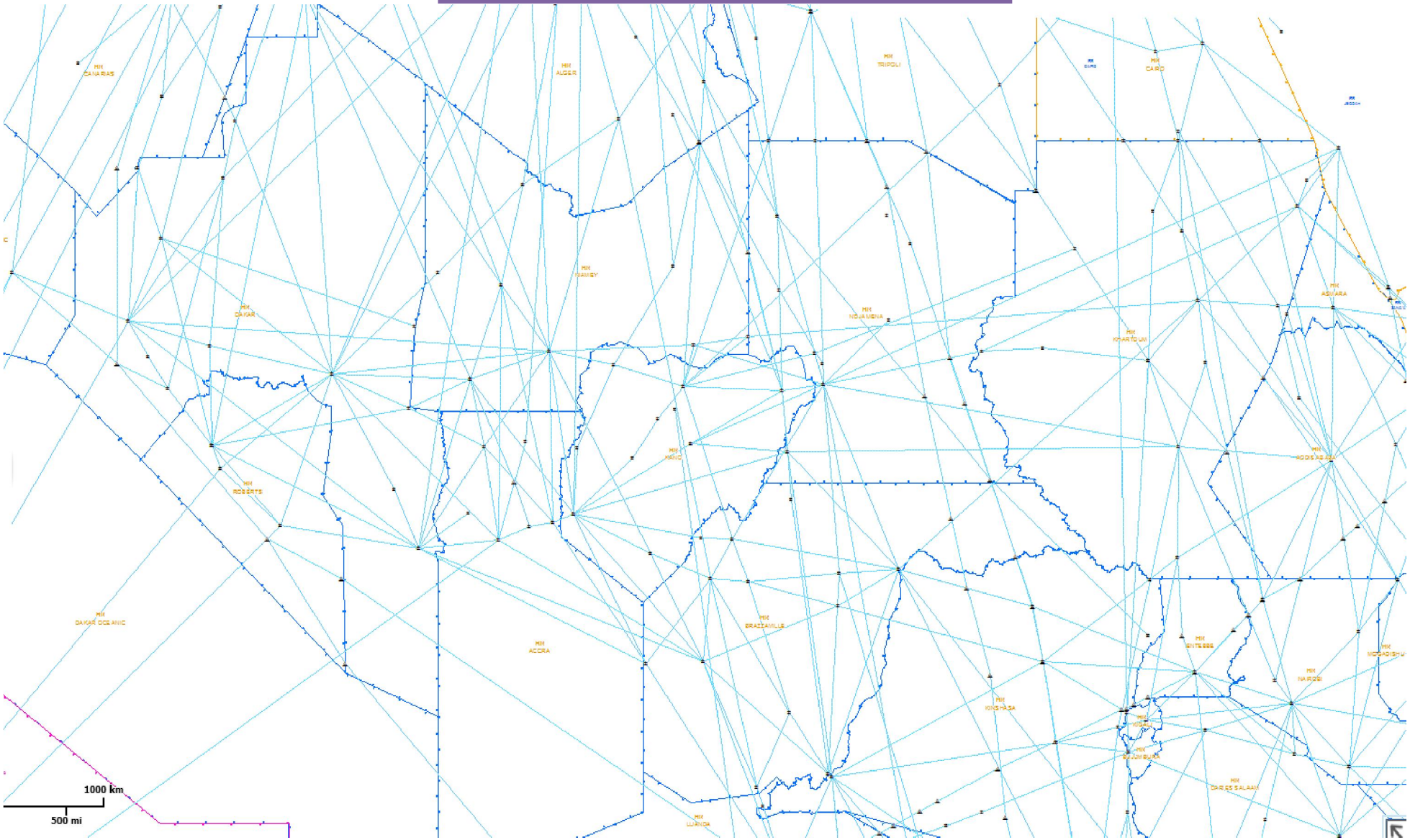
Figure 1. Simplified Planning Flow Chart



What Aircraft Operations Intend to Achieve



What Ground-based Constraints Make them Do



2.8 In order to guide Regional planning and implementation under the ASBUs methodology, a Regional Workshop on the Aviation Systems Block Upgrade (ASBU) methodology for planning and implementation of air navigation systems is to be held in Nairobi, Kenya, 21-25 October 2013. Amongst others, the workshop will have the opportunity review the ANRF (Air Navigation Reporting From), a replacement of the PFF (Performance Framework Form). The ANRF is recommended for application for setting planning targets, monitoring implementation, identifying challenges, measuring implementation as well as performance and reporting.

Critical path and implementation priorities

2.9 The PRND WG/3 meeting in Dakar 5-8 August 2013 established criteria for considering user requirements, developing trajectories based on PBN, facilitating the implementation of flexible routing including user preferred profiles in defined airspaces. The following elements will be applied through the use of matrixes and other tool that will be considered by the PRND Working Group:

Aircraft equipage

- Due regard should be given to the level of equipage (percentage of aircraft equipped) in a particular area or sub-region. However, it should be acknowledged that in general, latter day fleets are equipped with technologies that enable significant advantages from on-board capabilities. Consideration should therefore be given to enabling benefits from such investments.

Early, accessible benefits

- Advantage should be taken of *low-hanging fruits*. Consideration should be given to conditions that offer the best opportunities for successful implementation with the least delay, even though the benefits may not have high significance.
- Conversely, some of the most inefficient trajectories are in areas where there is little or no flexibility to improve them, making any effort to establish efficient trajectories significantly *cost-ineffective*. While not abandoning areas with the most roadblocks, they should be given lower priority.

Significance of benefits

- High density routes and those involving heavy aircraft operations generally imply that operational improvements would result in high aggregate benefits.
- High density flows (or areas of routing) also provide high aggregate benefits, improving on several established.

Surveillance implementation

- The current or immediate existence of surveillance should support PBN specification having stringent accuracy requirements, typically RNAV 5 en-route and RNAV 1 in terminal areas. This in turn presents opportunities for airspace and trajectory flexibilities. The availability

of surveillance in continental areas also facilitates the implementation of free routing.

CDM should continue to be one of the basic elements in considering the need for surveillance.

Duration of flights

- Duration of flights should be considered in prioritizing routes for inclusion into the AARC. ATS routes for city pair operations of four or more hours (jet time), should be given higher priority over shorter routes. Besides the significance of benefits, such routes also present less climb through complexities per distance.

Minimum benefits for purposes of reducing workload (focusing effort on higher benefits) have to be defined (NM, CO_2 reduced, % reduced (**00%0000**) *(to be further developed by the PRND WG)*

2.10 Further to the above the Working Group agreed on the following criteria for ATS routes inclusion into the AARC and their implementation:

a) The Priority Matrix established by the Working Group will be applied
b) City pair segments of four (4) hour (jet time) flights or more shall be prioritised into Phase 1
c) Implementation performance will be based primarily:
   i. best approximation of the user proposals. The percentage difference between the user proposals and the implemented trajectories shall be a measure of the shortfall which should remain to be addressed
   ii. implementation times. It will be critical to meet the implementation timelines agreed within the framework of APIRG and the extent to which this is met shall be factored into implementation performance. (This criterion is to be further developed).

2.11 The Working Group also agreed that the AARC Template should be improved to reflect benefits from the operational improvements.

2.12 The PRND WG/3 meeting received submissions for AARC from users. The Working Group agreed to include them in the AARC, however, due to time constraints for the meeting, the route proposals are yet to be developed further and coordinated with concerned FIRs. The trajectories as modified by the PRND WG/3 are reflected at **Appendix A** to this working paper.

2.13 In addition to the submissions defined in advance of the PRND WG/3 meeting, the PRND WG/3 meeting established Small Working Groups to define further trajectories as guided by specific users requirements, applying the established criteria.

2.14 The Sub-Group will note that while direct (great circle) segments generally support reduced flight times, this is more true in short segments than in longer ones. For long haul flights, in many cases it becomes preferable to fly away from the great circle track due to upper wind conditions. In oceanic airspace where random routing is already practical, aircraft may fly trajectories characterized by continually changing directions to seek the most

advantage from, or avoid winds. However, this random routing (flexible or free routing) is not supported by current operational capacity and infrastructure in the AFI continental airspace. In this regard, the PRND WG/3 developed multiple long distance tracks as at **Appendix B** to this working paper, to provide increased choice of tracks for varying conditions.

2.15 The Working Group recognized that the AFI Tactical Action Group (TAG) has identified ATC competence as one of the main causal or contributing factors of high volumes of ATS incidents and some AFI FIRs. Other factors include deficiencies in staffing, English Language proficiency and communication infrastructure. The meeting agreed however, that these should not be reason not propose establishment of efficient ATS route requirements. Instead, the routes requirements should be identified and agreed, and the factors delaying implementation, which mostly would be deficiencies, should be addressed as soon as possible to enable implementation. In this respect it was recalled that ICAO has various mechanisms to work with States in addressing deficiencies.

2.16 In view of the above the PRND Working Group formulated the following Conclusions and Decision:

DRAFT CONCLUSION 3/1: AFI ATS ROUTE CATALOGUE (AARC)

That, In order to facilitate the review and implementation of user ATS route requirements:

(a) the AARC is revised to reflect operational benefits, and is initially populated with user requirements as indicated in Appendix 13/6X to this report (**Appendix C)** to this working paper)

(b) AFI States and concerned international organizations are urged to review the Catalogue every six (6) months (January and July), note developments, and take action as applicable

2.17 Given past experiences, IATA was encouraged to facilitate the hosting of meetings in order to enable the coordination necessitated by the introduction of new ATS routes. ICAO was also requested to highlight in invitation State Letters, the need for States to include in their delegations, officials who not only have adequate knowledge of subject matters, but are adequately empowered to make decisions.

2.18 The meeting highlighted that while it is necessary to expedite the implementation of agreed ATS route proposals, time should be allowed for adequate safety assessments to be undertaken by the ANSPs. In certain cases of complexity of the airspace structures, the assessments and other preparatory elements such as ATC training can take up to 6 months. However, such time requirements are not frequent.

Strategies to spur implementation

2.19 The meeting agreed that the development of ATS routes to revise the AFI ATS route network will continue to be within the framework of the PRND Working Group and follow the prioritization established by the Working Group. While users may still make initiate proposal for ATS routes amendments through States, outside the purview of the

Working Group, implementation priority shall be given to ATS routes proposed to and endorsed by the PRND Working Group, except where safety may justify other approach.

2.20 The meeting noted that part of the slow progress in PBN implementation and accessing operational improvement for which technology already exists, is the lack of appreciation of the accessibility. Many ACCs still believe in older ATM methodologies as the best despite new technologies. This further complicates the sensitization of policy makers.

2.21 In view of the above, the Working Group identified the importance for wider sharing of knowledge and skills in implementing operational flexibilities enabled by PBN, through seminars and workshops. Accordingly, the meeting requested ICAO to arrange seminar/workshops to which implementation experiences in the Region could be shared to complement specific PBN expertise. The Working Group also requested the Secretariat to consider arranging implementation coordination meetings aligned to the six (6) AFI Homogeneous ATM areas and major traffic flows/routing areas.

2.22 The PRND WG/3 proposed revised terms of reference of the PBN Route Network Development Work Group as at **Appendix D** to this working paper, in order to adequately reflect the assignment by APIRG/18 of tasks relating environmental protection.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) note the information in this working paper; and

b) endorse the outcome and PRND WG/3 and the Conclusion/Decisions therefrom.
