International Civil Aviation Organization

INFORMATION PAPER

SP AFI/08-IP/1
14/10/08
English Only

SPECIAL AFRICA-INDIAN OCEAN (AFI) REGIONAL AIR NAVIGATION (RAN) MEETING

Durban, South Africa, 24 to 29 November 2008

Agenda Item 6: Development of a set of comprehensive work programmes in the air navigation field, aimed at improving efficiency of the air navigation system (Efficiency Committee)

SOUTH AFRICAN PBN IMPLEMENTATION PERFORMANCE OBJECTIVES

(Presented by South Africa)

SUMMARY

This information paper gives detailed information contained in South Africa's performance-based navigation (PBN) implementation roadmap. The South African PBN implementation roadmap has set priorities, targets and goals for the near-term (2008-2012), mid-term (2013-2017) and far-term (2018-2025) and is considered as the process that South Africa needs to follow in order to successfully implement PBN.

1. INTRODUCTION

1.1 This paper presents South Africa's Roadmap to PBN Implementation in accordance with ICAO Assembly Resolution A36-23 which established global objectives for the implementation of performance-based navigation (PBN). The sixteenth meeting of the AFI Planning and Implementation Regional Group (APIRG/16) established a PBN task force (TF) to develop a regional PBN implementation plan and assist the States with PBN implementation. This paper illustrates what South Africa is proposing in order to meet the PBN performance objectives and to focus the South African PBN implementation effort and to ensure that implementation is harmonised and interoperable with the global plan initiatives (GPIs) of the *Global Air Navigation Plan for CNS/ATM Systems* (Global Plan, Doc 9750) and the ICAO vision for a global air traffic management (ATM) system as envisaged in the *Global Air Traffic Management Operational Concept* (Doc 9854).

1.2 The South African PBN Roadmap details the framework within which the ICAO PBN concept will be implemented in South Africa through 2025. The Roadmap for PBN is guided by ICAO Doc. 9613, *Performance Based Navigation Manual*, and relevant SARPS. The primary driver for this plan is to maintain and increase safety, air traffic demand and capacity, and services and technology in consultation with relevant stakeholders.

2. BACKGROUND

2.1 The continuing growth of aviation in South Africa places increasing demands on airspace capacity and emphasises the need for the optimum utilisation of the available airspace. The IATA forecast, and the statistical modelling output indicates in projected total movement growth of 4.60% through 2017. Research performed by Transport Research Laboratory (TRL) of the United

Kingdom, under contract to Air Traffic and Navigation Services (ATNS), indicates a projected 8% traffic growth through 2020. General aviation (GA) continues to show strength and is expected to grow at an average rate of 5% per year.

2.2 Scheduled, non-scheduled and GA aircraft traffic movements are expected to increase on airways and direct routings. The increasing cost of fuel also presents a significant challenge to all segments of the aviation community. This anticipated growth and higher complexity of the air transportation system could result in increased flight delays, schedule disruptions, choke points, inefficient flight operations, and passenger inconvenience, particularly when unpredictable weather and other factors constrain airport and en-route capacity. Without improvements in system efficiency and workforce productivity, the aviation community and cost of operations will continue to increase. Upgrades to the air transportation system must leverage current and evolving capabilities in the near term, while building a foundation to address the future needs of the aviation community stakeholders. These circumstances can be partially alleviated by efficiencies in airspace and procedures through the implementation of PBN concepts.

3. DISCUSSION

3.1 Stakeholders: For implementation of the PBN concept, coordination with the aviation community through collaborative forums, and referencing the South African Airspace Master Plan and the ATM Roadmap is critical. It will assist aviation stakeholders in understanding operational goals, determining requirements, and considering future investment strategies by focusing on future efficiency and capacity needs while maintaining or improving the safety of flight operations by leveraging advances in navigation capabilities on the flight deck.

3.2 The stakeholders who will benefit from the concepts in this Roadmap include airspace operators, air traffic service providers, regulators and standards organisations. Driven by business needs, airlines and operators can use the Roadmap to plan future equipage and capability investments. Similarly, air traffic service providers can determine requirements for future automation systems, and more smoothly modernise ground infrastructure. Finally, regulators and standards organisations can anticipate and develop the key enabling criteria needed for implementation.

3.3 The Roadmap also supports other South African Civil Aviation Authority (SACAA) and government-wide planning processes. This Roadmap is a work in progress and will be amended through collaborative SACAA, ATNS and industry efforts. Consultations that establish a joint aviation community/government/industry strategy for implementing performance-based navigation are being held. Critical initiative strategies are required to accommodate the expected growth and complexity over the next two decades. These strategies have five key features:

- Expediting the development of performance-based navigation criteria and standards.
- Introducing airspace and procedural improvements in the near term.
- Providing benefits to operators who have invested in existing and projected capabilities.
- Establishing target dates for the introduction of navigation mandates for selected procedures and airspace, with an understanding that any mandate must be rationalised on the basis of benefits and costs.
- Defining new concepts and applications of performance-based navigation in the mid-term and far-term, and building synergy and integration among other capabilities toward the realisation of PBN goals.

3.4 Strategy: The South African PBN Implementation Roadmap provides a high-level strategy for the evolution of navigation capabilities to be implemented in three timeframes: near-term (2008-2012), mid-term (2013-2017), and far-term (2017-2025). The strategy rests upon two key navigation concepts; Area Navigation (RNAV) and Required Navigation Performance (RNP). It also encompasses instrument approaches, Standard Instrument Departure (SID) and Standard Terminal

Arrival (STAR) operations, as well as en route and oceanic operations. The section on far-term initiatives discusses integrated navigation, communication, surveillance and automation strategies.

3.5 SACAA, ATNS and aviation stakeholders are engaged in key harmonisation activities through their participation in ICAO's Required Navigation Performance and Special Operational Requirements Study Group (RNPSORSG), which is charged with implementing Performance-Based Navigation and also in ICAO regional forums. These activities enable the sharing of expertise, lessons learned, and plan for performance-based navigation.

3.6 Near Term (2006-2012) Mid Term (2013-2017) and Far Term (2018-2025) Key Tasks: The key tasks involved in the transition to performance-based navigation are to:

- Establish navigation service needs through to the far term that will guide infrastructure decisions and specify needs for navigation system infrastructure, and ensure funding for managing and transitioning these systems.
- Define and adopt a national policy enabling additional benefits based on RNP and RNAV.
- Identify operational and integration issues between navigation and surveillance, air-ground communications, and automation tools that maximise the benefits of RNP.
- Support mixed operations throughout the term of this Roadmap, in particular considering navigation system variations during the near term until appropriate standards are developed and implemented.
- Initiate rulemaking for mandates 7-10 years in advance.
- To support the South African Department of Defence requirements, develop the policies needed to accommodate the unique missions and capabilities of military aircraft operating in civil airspace.
- Harmonise the evolution of capabilities for interoperability across airspace operations.
- Increase emphasis on human factors, especially on training and procedures as operations increase reliance on appropriate use of flight deck systems.
- Facilitate and advance environmental analysis efforts required to support the development of RNAV and RNP procedures.
- Maintain consistent and harmonised global standards for RNAV and RNP operations.

3.7 Near-term (2008-2012): Initiatives in the near-term focus on investments by operators in current and new aircraft acquisitions; in satellite-based navigation and conventional navigation infrastructure as well as air traffic infrastructure investments. Key components include wide-scale RNAV implementation and the introduction of RNP for en route, terminal, and approach procedures. The near-term strategy will also focus on expediting the implementation and proliferation of RNAV and RNP procedures. As demand for air travel continues at healthy levels, choke points will develop and delays at the major airports will continue to climb. RNAV and RNP procedures will help alleviate those problems. Continued introduction of RNAV and RNP procedures will not only provide benefits and savings to the operators but also encourage further equipage. Additionally, key industry initiatives in this time frame will pave the road for mid-term and far-term capabilities.

3.7.1 **Oceanic Operations:** To promote global harmonisation, South Africa will continue to work closely with its international partners in promulgating reduced oceanic longitudinal/lateral separation minima between aircraft approved for RNP-10 and RNP-4 operations.

3.7.2 **En Route Operations:** For airspace and corridors requiring structured routes for flow management, South Africa will review existing RNAV routes. These routes will provide efficient flows between busy airports and feature limited entry and exit points, like “express lanes” on the highway.

3.7.3 **Terminal Operations:** RNAV reduces conflict between traffic flows by consolidating flight tracks. RNAV SIDs and STARs improve safety, capacity, and flight efficiency and also lower communication errors. The planning, development and implementation of RNAV SIDs and STARs at major airports and the making of associated changes in airspace design will be conducted. In addition implementation of RNP SIDs and STARs, in certain cases applying advanced functionality such as radius-to-fix (RF) path terminators to ensure repeatable turns where beneficial, and to permit more efficient design of limited airspace. South Africa is establishing the following strategies for RNAV and RNP SIDs:

- Introduce RNAV 1 SIDs to ensure maximum reduction in controller-pilot communications and to meet environmental or obstacle clearance requirements.
- Establish diverging RNAV 1 departure paths where feasible to take advantage of available airspace for maximum runway throughput.
- Where operationally feasible, apply seamless procedures from RNAV 1 SIDs to enroute entry points to achieve smooth transition between terminal and enroute RNAV operations.
- Sequence departures to maximise benefits of RNAV and identify automation requirements for traffic flow management, sequencing tools, flight plan processing, and tower data entry activities.

3.7.4 South Africa will also plan, develop and implement Basic-RNP 1 SIDs where RNAV 1 SIDs do not maximise benefits. South Africa is establishing the following implementation strategies for RNAV and RNP STARs:

- For maximum benefit, apply RNAV 1 STAR runway transitions that connect RNAV STARs to a standard instrument approach procedure (SIAP).
- In moderate to heavy traffic areas with merging RNAV arrival streams, identify requirements for tactical controller tools that maximise efficiency and throughput for RNAV arrival operations.
- Develop operational concepts and requirements for constant descent arrivals (CDAs) and for applying time of arrival control based on RNAV and RNP procedures.
- Implement Basic-RNP 1 STARs where RNAV 1 STARs do not maximise benefits.

3.7.5 **Approach Operations:** Operational changes, especially in the approach domain, are required in order to retain capacity in adverse weather conditions. One means for enabling such changes is to provide instrument approaches to all runways with sufficient terrain clearance. Instrument operations, in turn, can be improved by de-conflicting traffic flows or removing dependencies between flows, thus increasing capacity. To achieve optimum runway capacity in low visibility conditions, South Africa will introduce new RNAV (GNSS) based on RNP APCH NAV specification approaches to runways without existing instrument procedures. RNAV approaches include:

- minima for vertically guided approach services based on BARO VNAV navigation/vertical navigation LNAV/VNAV; and,
- minima for non-precision approaches based on LNAV/RNAV approaches with LPV minima equivalent to Category I ILS.

3.7.6 RNAV/STAR connecting to advanced features such as RF path terminators allow for the design of procedures that deliver measurable benefits to those operators equipped to execute them. Terminal automation requirements are being identified that would provide merging tools for controllers. Specifications for construction of LNAV/VNAV and LNAV approaches will soon be defined based on new and improved standards for RNP 0.3 (RNP APCH and RNP AR APCH). RPAT (Parallel Approach Transition) RNP will improve access to airports with parallel runways (separated by less than 4300 feet). RPAT applies during marginal VMC, when the airport acceptance rate is reduced due to discontinued use of parallel visual approaches.

3.7.7 RNP AR APCH, Special Aircraft and Aircrew Authorisation Required (SAAAR) instrument approaches permit a de-conflict of operations between adjacent airports and allow better runway access. Busy terminal areas and airports with challenging terrain have the greatest need for this capability. South Africa will develop RNP SAAAR approaches to runways that require features such as RNP less than 0.3, RF legs, and precise, guided turns on the missed approach. Close collaboration with and industry will determine the priority of implementation sites.

3.8 Mid Term (2013-2017) Priorities**:** In the mid term, increasing demand for air travel will continue to challenge the efficiencies of the air traffic management system. While the hub-and-spoke system will remain largely the same as today for major airline operations, the demand for more point-to-point service will create new markets and spur increases in low-cost carriers, air taxi operations, and on-demand services. Additionally, the emergence of Very Light Jets (VLJs) is expected to create new markets in the general and business aviation sectors for personal, air taxi, and point-to-point passenger operations. Many airports will thus experience significant increases in unscheduled traffic. In addition, many destination airports that support scheduled air carrier traffic are forecast to grow and to experience congestion or delays if efforts to increase their capacity fall short. As a result, additional airspace flexibility will be necessary to accommodate not only the increasing growth, but also the increasing air traffic complexity. The mid term will leverage these increasing flight capabilities based on RNAV and RNP, with a commensurate increase in benefits such as fuel-efficient flight profiles, better access to airspace and airports, greater capacity, and reduced delay. These incentives, which should provide an advantage over non-RNP operations, will expedite propagation of equipage and the use of RNP procedures.

3.9 To achieve efficiency and capacity gains partially enabled by RNAV and RNP, South Africa will pursue use of data communications (e.g., for controller-pilot communications) and enhanced surveillance functionality, e.g. ADS-Broadcast (ADS-B) and Multilateration. Data communications will make it possible to issue complex clearances easily and with minimal errors. ADS-B will expand or augment surveillance coverage so that track spacing and longitudinal separation can be optimised where needed (e.g., in non-radar airspace). Initial capabilities for flights to receive and confirm 3D clearances and time of arrival control based on RNP will be demonstrated in the mid-term. With data link implemented, flights will begin to transmit 4D trajectories (a set of points defined by latitude, longitude, altitude, and time.) Stakeholders must therefore develop concepts that leverage this capability.

3.9.1 **Oceanic Evolution:** In the mid-term, South Africa will endeavour to work with international air traffic service providers to promote the application of RNP10 and RNP4 in additional sub-regions of the oceanic environment. The purpose is to achieve 50/50 and 30/30 NM separation minima between qualified aircraft with ADS-C and controller-pilot data link communication capabilities. This effort could yield a seamless oceanic standard across service provider boundaries. Benefits will include more direct, wind-efficient routings and greater flight path flexibility.

3.9.2 En Route Evolution:

- **RNAV Operations:** In the mid-term, RNAV will continue to enable use of operator-preferred flight paths not tied to the location of ground-based NAVAIDs. RNAV-2 operations for flight in positive control airspace (i.e., at or above FL180) are expected to be mandated by 2015. This will enable airspace redesign and route optimisation based on RNAV 2 operations. RNAV operations based on use of distance measuring equipment, inertial reference unit, and GPS are expected to continue through the mid term. Where structure is needed for routing around and through busy terminal areas, South Africa will develop additional routes serving low-altitude operators flying in close proximity to large airports. Where structure is not needed, these operators will fly direct routings.
- **Implementation of RNP:** By the end of the mid term other benefits of RNP will have been enabled, such as flexible procedures to manage the mix of faster and slower

aircraft in congested airspace and use of low RNP values and narrow routing corridors to avoid convective weather or military use airspace. In addition, flexible RNP rerouting will be demonstrated as aircraft become capable of reroutes using fixed radius transitions and RF legs.

- **Automation for RNAV and RNP Operations:** By the end of the mid term enhanced en route automation will allow the assignment of RNAV and RNP routes based upon specific knowledge of an aircraft's RNP capabilities. En route automation will use collaborative routing tools to assign aircraft priority, since the automation system can rely upon the aircraft's ability to change a flight path and fly safely around problem areas. This functionality will enable the controller to recognise aircraft capability and to match the aircraft to dynamic routes or procedures, thereby helping appropriately equipped operators to maximise the predictability of their schedules. Conflict prediction and resolution in most en route airspace must improve as airspace usage increases. Path repeatability achieved by RNAV and RNP operations will assist in achieving this goal. Mid-term automation tools will facilitate the introduction of RNP offsets and other forms of dynamic tracks for maximising the capacity of airspace. By the end of the mid term, en route automation will have evolved to incorporate more accurate and frequent surveillance reports through ADS-B, and to execute problem prediction and conformance checks that enable offset manoeuvres and closer route spacing (e.g., for passing other aircraft and manoeuvring around weather).

3.9.3 **Terminal Evolution:** During this period, RNAV 1 will become a required capability for flights arriving and departing major airports based upon the needs of the airspace, such as the volume of traffic and complexity of operations. This will ensure the necessary throughput and access, as well as reduced controller workload, while maintaining safety standards. South Africa expects to employ RNAV 1 SIDs and STARs at the major airports, and at satellite airports located within busy terminal airspace. With RNAV-1 operations as the predominant form of navigation in terminal areas by the end of the mid term, South Africa will have the option of removing conventional terminal procedures that are no longer expected to be used.

- **RNP SIDs and STARs:** Basic-RNP 1 SIDs and STARs will be implemented at the nation's busiest airports to provide efficient paths and optimal spacing of flows. Basic-RNP 1 SIDs will enable consistent, predictable flight tracks and additional egress routes for higher throughput to mitigate delays. Basic-RNP 1 STARs will connect to approaches using 3D operations and time of arrival control as appropriate to provide arrival efficiency. The aviation community will conduct trials that combine data link and enhanced automation capabilities to achieve improved strategic management for sequencing and spacing. RNP SIDs and STARs based on lower RNP values will be introduced as necessary to achieve closer track spacing and efficiencies where aircraft capabilities exist. South Africa will pursue institution of curved parallel paths for both departures and arrivals in this time frame to achieve higher throughput and runway utilisation at airports with parallel runways.
- **Terminal Automation:** Terminal automation will be enhanced with tactical controller tools to manage complex merges in busy terminal areas. As data communications become available, the controller tools will apply knowledge of flights' estimates of time of arrival at upcoming waypoints, and altitude and speed constraints, to create efficient manoeuvres for optimal throughput. Terminal automation will also sequence flights departing busy airports more efficiently than today. This capability will be enabled as a result of RNP and flow management tools. Flights arriving and departing busy terminal areas will follow automation-assigned RNP routes.

3.9.4 **Approach Evolution:** In the mid term, implementation priorities for instrument approaches will still be based on Basic-RNP 1, RNP APCH and RNP AR APCH. To accomplish this, RNP SAAAR approach procedures will leverage enhanced surveillance capabilities. Flight deck automation that meets the requirements for aids to visual acquisition (e.g., cockpit display of traffic information with position/state information about proximate traffic) may be an option for this time frame.

3.9.5 Summary of Mid-Term (2013-2017) Priorities:

- Lower RNP available as required.
- Oceanic RNP combined with other capabilities for reduced separation minima where beneficial, and increased use of operator-preferred routes in oceanic operations.
- For arriving and departing all major airports, RNAV 1 SIDs/STARs and Basic-RNP 1 SIDs/STARS.
- Improved sequencing for arrivals and departures.
- Airspace redesign and procedures for RNAV and RNP with 3D, Constant Descent Arrival (CDA).
- Closely spaced parallel and converging runway operations based on RNP.

3.9.6 Enabling Criteria and Standards:

- Standards for integrated Required Navigation Performance (RNP), Required Surveillance Performance (RSP), and Required Communications Performance (RCP).
- Equivalent visual operations criteria.

3.9.7 Policy

- Rulemaking for all mandates.

3.9.8 Requirements Analysis and Concept Development

- Procedures and automation for integrating RNP, RCP, RSP.
- Enhanced traffic flow management tools.
- Procedures and automation for integrated flight planning, routing, and sequencing.

3.10 <u>Far Term (2018-2025): Achieving a Performance-Based Navigation System</u>: The far-term environment will be characterised by continued growth in air travel and increased air traffic complexity. No one solution or simple combination of solutions will address the inefficiencies, delays, and congestion anticipated to result from the growing demand for air transportation. Therefore, South Africa will need an operational concept that exploits the full capability of the aircraft in this time frame and combines key performance-based elements (including RNP, RCP, and RSP) into a unified overall concept for achieving performance-based operations.

3.11 <u>Far Term Key Strategies</u>: Airspace operations in the far term will make maximum use of advanced flight deck automation that integrates CNS capabilities. RNP, RCP, and RSP standards will define these operations. Separation assurance will remain the principal task of air traffic management in this time frame. This task is expected to leverage a combination of aircraft and ground-based tools. Tools for conflict detection and resolution, and for flow management, will be enhanced significantly to handle increasing traffic levels and complexity in an efficient and strategic manner.

3.12 Strategic problem detection and resolution will result from better knowledge of aircraft position and intent, coupled with automated, ground-based problem resolution. In addition, pilot and air traffic controller workload will be lowered by substantially reducing voice communication of clearances, and furthermore using data communications for clearances to the flight deck. Workload will also decrease as the result of automated confirmation (via data communications) of flight intent from the flight deck to the ground automation.

3.13 With the necessary aircraft capabilities, procedures, and training in place, it will become possible in certain situations to delegate separation tasks to pilots and to flight deck systems that depict traffic and conflict resolutions. Procedures for airborne separation assurance will reduce reliance on ground infrastructure and minimise controller workload. As an example, in IMC an aircraft could be instructed to follow a leading aircraft, keeping a certain distance. Once the pilot agreed, ATC would transfer responsibility for maintaining spacing (as is now done with visual approaches).

3.14 Performance-based operations will exploit aircraft capabilities for "electronic" visual acquisition of the external environment in low-visibility conditions, which may potentially increase runway capacity and decrease runway occupancy times. Improved wake prediction and notification technologies may also assist in achieving increased runway capacity by reducing reliance on wake separation buffers.

3.15 System-wide information exchange will enable real-time data sharing of NAS constraints, airport and airspace capacity, and aircraft performance. Electronic data communications between the ATC automation and aircraft, achieved through data link, will become widespread—possibly even mandated in the busiest airspace and airports. The direct exchange of data between the ATC automation and the aircraft FMS will permit better strategic and tactical management of flight operations.

3.16 Aircraft will downlink to the ground-based system their position and intent data, as well as speed, weight, climb and descent rates, and wind or turbulence reports. The ATC automation will uplink clearances and other types of information, for example, weather, metering, choke points, and airspace use restrictions.

3.17 To ensure predictability and integrity of aircraft flight path, RNP will be mandated in busy en route and terminal airspace. RNAV operations will be required in all other airspace (except oceanic). Achieving standardised FMS functionalities and consistent levels of crew operation of the FMS is integral to the success of this far-term strategy.

3.18 The most capable aircraft will meet requirements for low values of RNP (RNP 0.3 or lower en route). Flights by such aircraft are expected to benefit in terms of airport access, shortest routes during IMC or convective weather, and the ability to transit or avoid constrained airspace, resulting in greater efficiencies and fewer delays operating into and out of the busiest airports.

3.19 Enhanced ground-based automation and use of real-time flight intent will make time-based metering to terminal airspace a key feature of future flow management initiatives. This will improve the sequencing and spacing of flights and the efficiency of terminal operations.

3.20 Uniform use of RNP for arrivals and departures at busy airports will optimise management of traffic and merging streams. ATC will continue to maintain control over sequencing and separation; however, aircraft arriving and departing the busiest airports will require little controller intervention. Controllers will spend more time monitoring flows and will intervene only as needed, primarily when conflict prediction algorithms indicate a potential problem.

3.21 More detailed knowledge of meteorological conditions will enable better flight path conformance, including time of arrival control at key merge points. RNP will also improve management of terminal arrival and departure with seamless routing from the en route and transition segments to the runway threshold. Enhanced tools for surface movement will provide management capabilities that synchronise aircraft movement on the ground; for example, to coordinate taxiing aircraft across active runways and to improve the delivery of aircraft from the parking areas to the main taxiways.

3.21.1 **Summary of Far Term Key Strategies:** The key strategies for instituting performance-based operations employ an integrated set of solutions.

- Airspace operations will take advantage of aircraft capabilities, i.e. aircraft equipped with data communications, integrated displays, and FMS.
- Aircraft position and intent information directed to automated, ground-based ATM systems, strategic and tactical flight deck-based separation assurance in selected situations (problem detection and resolution).
- Strategic and tactical flow management will improve through use of integrated airborne and ground information exchange.
- Ground-based system knowledge of real-time aircraft intent with accurate aircraft position and trajectory information available through data link to ground automation.
- Real-time sharing of National Air Space (NAS) flight demand and other information achieved via ground-based and air-ground communication between air traffic management and operations planning and dispatch.
- Overall system responsiveness achieved through flexible routing and well-informed, distributed decision-making.
- Systems ability to adapt rapidly to changing meteorological and airspace conditions.
- System leverages through advanced navigation capabilities such as fixed radius transitions, RF legs, and RNP offsets.
- Increased use of operator-preferred routing and dynamic airspace.
- Increased collaboration between service providers and operators.

3.21.2 Operations at the busiest airports will be optimised through an integrated set of capabilities for managing pre-departure planning information, ground-based automation, and surface movement.

- RNP-based arrival and departure structure for greater predictability.
- Ground-based tactical merging capabilities in terminal airspace.
- Integrated capabilities for surface movement optimisation to synchronise aircraft movement on the ground. Improved meteorological and aircraft intent information shared via data link.

3.21.3 **Key Research Areas:** The aviation community must address several key research issues to apply these strategies effectively. These issues fall into several categories:

Navigation

- To what extent can lower RNP values be achieved and how can these be leveraged for increased flight efficiency and access benefits?
- Under what circumstances RNAV should be mandated for arriving/departing satellite airports to enable conflict-free flows and optimal throughput in busy terminal areas?

Flight Deck Automation

- What FMS capabilities are required to enable the future concepts and applications?
- How can performance-based communication and surveillance be leveraged in the flight deck to enable far-term strategies such as real-time exchange of flight deck data?

Automation

- To what extent can lateral or longitudinal separation assurance be fully automated, in particular on final approach during parallel operations?

- To what extent can surface movement be automated, and what are the cost-benefit trade-offs associated with different levels of automation?
- To what extent can conflict detection and resolution be automated for terminal ATC operations?

Procedures

- How can time of arrival control be applied effectively to maximise capacity of arrival or departure operations, in particular during challenging wind conditions?
- In what situations is delegation of separation to the flight crews appropriate?
- What level of onboard functionality is required for flight crews to accept separation responsibility within a manageable workload level?

Airspace

- To what extent can airspace be configured dynamically on the basis of predicted traffic demand and other factors?
- What separation standards and procedures are needed to enable smoother transition between en route and terminal operations?
- How can fuel-efficient procedures such as CDAs be accomplished in busy airspace?

Policy

- How is information security ensured as information exchange increases?
- What are the policy and procedure implications for increased use of collaborative decision-making processes between the service provider and the operator?

3.21.4 The answers to these and other research questions are critical to achieving a performance-based airspace system. Lessons learned from the near-term and mid-term implementation of the Roadmap will help answer some of these questions. The aviation community will address others through further concept development, analysis, modelling, simulation, and field trials. As concepts mature and key solutions emerge, the community will develop more detailed implementation strategies and commitments.

4. CONCLUSION

4.1 .In order to effectively implement PBN, South Africa has created a comprehensive PBN Implementation Roadmap in line with implementation strategies contained in ICAO Doc 9613 *Performance Based Navigation Manual.* The South African PBN Implementation Roadmap has set priorities, targets and goals for Near Term (2008-2012), Mid Term (2013-2017) and Far Term (2018-2025). This PBN Implementation Roadmap is considered a “work in progress” and will be amended as required.

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