TANZANIA CIVIL AVIATION AUTHORITY

TANZANIA
Performance Based Navigation
Implementation Plan

Version 1
May 2011

RECORD OF AMENDENTS

No	Date applicable	Date entered	Entered by

DISTRIBUTION LISTS

NAME	DEPT/SECTION/ORG	NO.
BOARD OF DIRECTORS	TCAA BOARD	001
DIRECTOR GENERAL	TCAA	002
DIRECTOR OF SAFETY REGULATION	TCAA	003
CORPORATION SECRETARY	TCAA	004
DIRECTOR ANS	TCAA	005
AIRPORT AUTHORITY	TAA	006
MET AGENCY	TMA	007
SAFETY MANAGER	TCAA	008
LIBRARY	TCAA	009
ATS STATIONS	TCAA	010
MANAGING DIRECTOR	KADCO	011
EXECUTIVE SECRETARY TAOA	TAOA	012

Preface

1. Requirement for PBN

1.1. ICAO Assembly Resolution A36-23 calls for each State to develop a national Performance-Based Navigation (PBN) implementation plan. This PBN implementation plan is based on ICAO AFI PBN Implementation Plan template developed by the APIRG PBN Task Force. The plan is linked to other State aviation development plans including the conversion of existing coordinates to the WGS-84 coordinate system.

1.2. The plan encompasses all future plans relating to PBN implementation in the Dar es Salaam FIR as regards to; en-route operations (domestic and international), terminal and approach operations including SIDs and STARs.

2. Need for PBN implementation plan

2.1. With RVSM implemented in the world, the main tool for optimizing the airspace structure is the implementation of PBN, which will foster the necessary conditions for the utilization of RNAV and RNP capabilities by a significant portion of airspace users.

2.2. Current planning by the Regional Planning and Implementation Groups is based on the Air Navigation Plans and the Regional CNS/ATM Plans. Currently, these plans are mostly made up of tables that do not contain the necessary details for the implementation of each of the CNS and ATM elements. For this reason, the AFI Region has developed its Regional PBN implementation plan. The Tanzania PBN implementation plan is developed as a necessary concurrent and follow-on step to implement the regional plan at the State level and address PBN implementation strategy at the national level.

2.3. The national PBN Implementation Plan is intended ~~by each State,~~ to provide proper guidance and direction to the domestic air navigation service provider(s), airspace operators and users, regulating agency, as well as foreign operators who operate or plan to operate in the Dar es Salaam FIR. This guidance addresses the planned evolution of navigation, as one of the key systems supporting air traffic management, and describes the RNAV and RNP navigation applications that should be implemented in at least the short and medium term.

2.4. Through this implementation plan, the Tanzania Civil Aviation Authority remains committed to achieving the objectives of the AFI PBN in line with the Global Navigation Plan and navigation solution

3. Objectives of the PBN Implementation Plan

The PBN implementation plan is implemented in order to meet the following strategic objectives:

a) provide a high-level strategy for the evolution of the navigation applications to be implemented in Tanzania in the short term (2008-2012) and medium term (2013-2016). This strategy is based on the concepts of PBN, Area Navigation (RNAV) and Required Navigation Performance (RNP), which will be applied to aircraft operations involving instrument approaches, standard departure (SID) routes, standard arrival (STAR) routes, and ATS routes in accordance with the implementation goals in the Assembly resolution;

b) ensure that the implementation of the navigation portion of the CNS/ATM system is based on clearly established operational requirements;

c) avoid unnecessarily imposing the mandate for multiple equipment on board or multiple systems on the ground;

d) avoid the need for multiple airworthiness and operational approvals for intra- and inter-regional operations;

e) prevent commercial interests from outdoing ATM operational requirements, generating unnecessary costs for the State as well as for airspace users.

4. Intent of the PBN Implementation Plan

4.1. The PBN Implementation Plan is developed by the State in conjunction with the stakeholders concerned and is intended to assist the main stakeholders of the aviation community plan a gradual transition to the RNAV and RNP concepts. The main stakeholders of the aviation community that benefit from this plan and involved in the development process are:

a) Airspace operators and users
b) Air navigation service providers
c) Regulating agencies
d) National and international organizations

4.2. The PBN Implementation Plan is intended to assist the main stakeholders of the aviation community plan the future transition and their investment strategies. For example, airlines and operators can use this roadmap to plan future equipage and additional navigation capability investments; air navigation service providers can plan a gradual transition for the evolving ground infrastructure. Regulating agencies will be able to anticipate and plan for the criteria that will be needed in the future as well as the future regulatory workload and associated training requirements for their work force.

5. Principles applied in developing the PBN Implementation Plan or Roadmap

The implementation of PBN in Tanzania is based on the following principles;

a) Continued application of conventional air navigation procedures during the transition period, to guarantee availability by users that are not RNAV- and/or RNP-equipped;

b) Development of airspace concepts, applying airspace modeling tools as well as real-time and accelerated simulations, which identify the navigation applications that are compatible with the aforementioned concept;

c) Cost-benefit analysis is conducted to justify the implementation of the RNAV and/or RNP concepts in each particular airspace;

d) Pre- and post-implementation safety assessments are conducted to ensure the application and maintenance of the established target levels of safety.

e) Ensuring that the National and Regional PBN plans are not in conflict.

Table of Contents

1. Introduction

1.1. The Tanzania PBN implementation plan details the framework within which the ICAO PBN concept will be implemented in the United Republic of Tanzania for the foreseeable future. The plan is guided by the AFI Region PBN implementation Plan, ICAO Doc 9613, SARPs, AIP and other relevant documents.

1.2. The primary drivers for this plan include safety enhancement, improved operational efficiency, increased airspace capacity and improved technology. The plan also supports national and international interoperability and global harmonization

2. Background

2.1. The continuing growth of aviation places increasing demands on airspace capacity and emphasizes the need for the optimum utilization of the available airspace. Growth in scheduled and general aviation aircraft is expected to increase point-to-point 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 capacity. Without improvements in system efficiency and workforce productivity, the 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 the 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.

2.2. In setting out requirements for navigation applications on specific routes or within a specific airspace, it is necessary to define requirements in a clear and concise manner. This is to ensure that both flight crew and ATC are aware of the on-board area navigation (RNAV) system capabilities and to ensure that the performance of the RNAV system is appropriate for the specific airspace requirements.

2.3. The early use of RNAV systems arose in a manner similar to conventional ground-based routes and procedures. A specific RNAV system was identified and its performance was evaluated through a combination of analysis and flight testing. For domestic operations the initial systems used VOR and DME for position estimation. For oceanic operations, inertial navigation systems (INS) were employed.

2.4. These ‘new’ systems were developed, evaluated and certified. Airspace and obstacle clearance criteria were developed on the basis of available equipment performance. Requirements specifications were based upon available capabilities and, in some implementations, it was necessary to identify the individual models of equipment that could be operated within the airspace concerned. Such prescriptive requirements result in delays to the introduction of new RNAV system capabilities and higher costs for maintaining appropriate certification. To avoid such prescriptive specifications of requirements, the PBN concept introduces an alternative method for defining equipage requirements by specification of the performance requirements. This is termed Performance Based Navigation (PBN)

3. Performance Based Navigation (PBN)

3.1. Concept

3.1.1. PBN is a concept that encompasses both RNAV and RNP and revises the current RNP concept. Performance based navigation is increasingly seen as the most practical solution for regulating the expanding domain of navigation systems.

3.1.2. Under the traditional approach, each new technology is associated with a range of system-specific requirements for obstacle clearance, aircraft separation, operational aspects (e.g. arrival and approach procedures), aircrew operational training and training of air traffic controllers. However, this system-specific approach imposes an unnecessary effort and expense on States, airlines and ANSPs.

3.1.3. Performance based navigation eliminates the need for redundant investment in developing criteria and in operational modifications and training. Rather than build an operation around a particular system, under performance based navigation the operation is defined according to the operational goals, and the available systems are then evaluated to determine whether they are supportive.

3.1.4. The advantage of this approach is that it provides clear and standardized operational approvals which enable harmonized and predictable flight paths resulting in more efficient use of existing aircraft capabilities, improved safety, greater airspace capacity, better fuel efficiency and resolution of environmental issues.

3.1.5. The PBN concept specifies aircraft RNAV system performance requirements in terms of accuracy, integrity, availability, continuity and functionality needed for the proposed operations in the context of a particular airspace concept. The PBN concept represents a shift from sensor-based to performance-based navigation. Performance requirements are identified in navigation specifications, which also identify the choice of navigation sensors and equipment that may be used to meet the performance requirements. These navigation specifications are defined at a sufficient level of detail to facilitate global harmonization by providing specific implementation guidance for States and operators.

3.1.6. Under PBN, generic navigation requirements are defined based on the operational requirements. Operators are then able to evaluate options in respect of available technologies and navigation services that could allow these requirements to be met. The chosen solution would be the most cost effective for the operator, rather than a solution being imposed as part of the operational requirements. Technologies can evolve over time without requiring the operation itself to be revisited, as long as the requisite performance is provided by the RNAV system. As part of the future work of the ICAO, it is anticipated that other means for meeting the requirements of the navigation specifications will be evaluated and may be included in the applicable navigation specifications, as appropriate.

3.1.7. ICAO's PBN concept aims to ensure global standardization of RNAV and RNP specifications and to limit the proliferation of navigation specifications in use worldwide. It is a new concept based on the use of RNAV systems. Significantly, it is a move from a limited statement of required performance accuracy to more extensive statements for required performance in terms of accuracy, integrity, continuity and availability, together with descriptions of how this performance is to be achieved in terms of aircraft and flight crew requirements.

3.2. RNAV current status in Tanzania

3.2.1. RNAV, ATS routes, SIDs, STARs and approaches

3.2.1.1. High level IFR en-route navigation

Currently there are two RNAV 10 (RNP 4) routes in the upper airspace namely **UT146 and UT252**

All other routes in the upper airspace are conventional ATS routes

3.2.1.2. Low level IFR en-route navigation

Currently there are no RNAV (RNP) routes in the lower airspace

3.2.1.3. Terminal procedures

There are two Terminal Control Areas in the Dar es Salaam FIR namely Dar es Salaam TMA and Kilimanjaro TMA. Julius Nyerere International Airport (JNIA) and Abeid Amani Karume International Airport are within the Dar es Salaam TMA while Kilimanjaro International Airport is within the Kilimanjaro TMA.

3.2.1.4. Approach procedures

a) Julius Nyerere International Airport (HTDA)

- Runway 05
    - DV DVOR/DME — CAT A-B and C-D
    - DV DVOR/ILS — CAT A-B and C-D
    - DV DVOR/Locator DS — CAT A-B and C-D
    - DS/ILS — CAT A-B and C-D
    - DS/Locator — CAT A-B and C-D
    - RNAV(GNSS)

- Runway 23
    - DV DVOR/DME — CAT A-B and C-D
    - DV DVOR/LDM — CAT A-B and C-D
    - Locator DM DME — CAT A-B and C-D
    - DVOR/DME using DME ARC
    - RNAV(GNSS)

b) Abeid Amani Karume International airport (HTZA)

- Runway 36
    - ZV VOR/DME — CAT A-B and C-D
    -

c) Kilimanjaro International Airport (HTKJ)

- Runway 09
    - High Level KV DVOR/ILS
    - KV DVOR/ILS CAT A-B and C-D
    - Locator KL CAT A-B and C-D
    - KB/ILS CAT A-B and C-D
    - Locator KB CAT A-B and C-D
    - RNAV(GNSS)
- Runway 27
    - RNAV(GNSS)

d) Mwanza Airport (HTMW)
- Runway 13
    - MZ DVOR/DME CAT A-B and C-D
- Runway 31
    - MZ DVOR/DME CAT A-B and C-D

3.2.2. Limitations of existing navigation procedures

3.2.2.1. High level IFR en-route navigation
- Large separation minima
- No parallel routes
- Limited number VOR/DME facilities
- Poor geometry of DME facilities
- Limited IRS/INS equipped aircraft
- Airspace restrictions (Ngerengere Prohibited Area)

3.2.2.2. Low level IFR en-route navigation
- Large separation minima
- No parallel routes
- Limited number VOR/DME facilities
- Poor geometry of DME facilities
- Limited IRS/INS equipped aircraft
- Airspace restrictions (Ngerengere Prohibited Area)

3.2.2.3. Terminal procedures
- SIDs and STARs are not segregated
- SIDs and STARs are not linked to domestic ATS route network.

3.2.2.4. Approach procedures
- Precision approach procedures are not provided for both runways

3.2.3. Fleet RNAV equipage

3.2.3.1. RNAV equipped

………………………………………………………………………………………
………………………………………………………………………………………
………………………………………………………………………………………
………………………………………………………………………………………
………………………………………………………………………………………
…………

3.2.3.2. RNAV approved

……………………………………………………………………………………
……………………………………………………………………………………
……………………………………………………………………………………
……………………………………………………………………………………
……………………………………………………………………………………
…………

3.2.3.3. GNSS equipped

……………………………………………………………………………………
……………………………………………………………………………………
……………………………………………………………………………………
……………………………………………………………………………………
……………………………………………………………………………………
…………

3.2.3.4. Non-GNSS

……………………………………………………………………………………
……………………………………………………………………………………
……………………………………………………………………………………
……………………………………………………………………………………
……………………………………………………………………………………
…………

3.3. Benefits of PBN and global harmonization

3.3.1. PBN offers a number of advantages over the sensor-specific method of developing airspace and obstacle clearance criteria. These include:

a. Reduces need to maintain sensor-specific routes and procedures, and their associated costs. For example, moving a single VOR ground facility can impact dozens of procedures, as that VOR can be used on routes, VOR approaches, as part of missed approaches, etc. Adding new sensor specific procedures will compound this cost, and the rapid growth in available navigation systems would soon make system-specific routes and procedures unaffordable.

b. Avoids need for development of sensor-specific operations with each new evolution of navigation systems, which would be cost-prohibitive.

c. Allows more efficient use of airspace (route placement, fuel efficiency, noise abatement).

d. Clarifies the way in which RNAV systems are used.

e. Facilitates the operational approval process for operators by providing a limited set of navigation specifications intended for global use.

3.3.2. RNAV and RNP specifications facilitate more efficient design of airspace and procedures, which collectively result in improved safety, access, capacity, predictability, operational efficiency and environmental effects. Specifically, RNAV and RNP may:

a. Increase safety by using three-dimensional (3D) approach operations with course guidance to the runway, which reduce the risk of controlled flight into terrain.

b. Improve airport and airspace access in all weather conditions, and the ability to meet environmental and obstacle clearance constraints.

c. Enhance reliability and reduce delays by defining more precise terminal area procedures that feature parallel routes and environmentally optimized airspace corridors. Flight management systems (FMS) will then be poised to save operators time and money by managing climb, descent, and engine performance profiles more efficiently.

d. Improve efficiency and flexibility by increasing use of operator-preferred trajectories airspace-wide, at all altitudes. This will be particularly useful in maintaining schedule integrity when convective weather arises.

e. Reduce workload and improve productivity of air traffic controllers.

3.3.3. Performance-based navigation will enable the needed operational improvements by leveraging current and evolving aircraft capabilities in the near term that can be expanded to address the future needs of aviation stakeholders and service providers.

3.4. Stakeholders

3.4.1. Coordination is critical with the aviation community through collaborative forums. This will assist aviation stakeholders in understanding operational goals, determining requirements, and considering future investment strategies. This, in turn, enables the aviation stakeholders to focus on addressing future efficiency and capacity needs while maintaining or improving the safety of flight operations by leveraging advances in navigation capabilities on the flight deck. RNAV and RNP have reached a sufficient level of maturity and definition to be included in key plans and strategies, such as this State PBN plan.

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

3.4.3. This plan is a work in progress and will be amended through collaborative AFI Region States, industry efforts and consultations that establish a joint aviation community/government/industry strategy for implementing performance-based navigation. Critical initiative strategies are required to accommodate the expected growth and complexity over the next two decades. These strategies have five key features:

a. Expediting the development of performance-based navigation criteria and standards.

b. Introducing airspace and procedure improvements in the near term.

c. Providing benefits to operators who have invested in existing and upcoming capabilities.

d. Establishing target dates for the introduction of navigation mandates for selected procedures and airspace, with an understanding that any mandate must be rationalized on the basis of benefits and costs.

e. Defining new concepts and applications of performance-based navigation for the mid-term and long-term and building synergy and integration among other capabilities toward the realization of the AFI Region PBN goals.

4. Challenges

4.1. Increasing demands

4.1.1. Status of existing air operators

		Domestic	Foreign
1	Scheduled		
2	Non Scheduled		
2	General Aviation		

4.1.2. Expected increase of international operators.

		Domestic	Foreign
1	Scheduled		
2	Non Scheduled		
2	General Aviation		

4.1.3. Traffic projection (scheduled, non-scheduled, GA)

		2011	2012	2013
1	Scheduled	2,578,550	2,764,206	2,963,229
2	Non Scheduled	663,157	733,452	811,198
2	General Aviation	24,938	26,459	28,073

4.1.4. New aerodromes
One new airport is expected to be operational by 2012 and major regional airport are being upgraded to accommodate medium category aeroplanes.

4.2. Operational objectives

4.2.1. En-route

a. Oceanic and remote continental - N/A
b. Continental – To increase airspace capacity and provide direct routing

4.2.2. Terminal Area (Departures and Arrivals)

a. Provide an efficient link to the TMA and en-route structure.

b. Increase number of aircraft operations in a single runway environment.

c. Reduce air traffic controller’s workload.

d. Reduce CFIT

4.2.3. Approach.

a. Increase operations in a single runway environment.
b. Reduce air traffic controller's workload.
c. Provide lower aerodrome operating minima
d. Provide vertical guidance.
e. Redundancy to landing NAVAIDS

5. AFI PBN Regional plan summary

5.1. Near-Term (2008-2012)

5.1.1. Summary table Near-Term (2008-2012)

Airspace	Nav. Specifications	Nav. Specifications where Operationally Required
En-Route Oceanic	RNAV-10	RNP-4
En-Route Remote Continental	RNAV-10	RNP-4
En-Route Continental	RNAV-5	RNAV-1
TMA Arrival/Departure	RNAV-1 in a surveillance environment	RNAV
	Basic RNP-1 in non-surveillance environment	RNAV
Approach	RNP APCH with Baro-VNAV OR RNP AR APCH if required	RNAV

5.1.2. Near-Term implementation targets

a) RNP APCH (with Baro-VNAV) in 30% of instrument runways by 2010 and 50% by 2012 and priority given to airports with operational benefits
b) RNAV-1 SID/STAR for 30% of international airports by 2010 and 50% by 2012 and priority given to airports with RNP Approach
c) Review existing conventional and RNAV routes to transition to PBN RNAV-5 or where operationally required RNAV-2/1 by 2012.

5.2. Mid-Term (2013-2016)

5.2.1. Summary table Near-Term (2013-2016)

Airspace	Nav. Specifications	Nav. Specifications where Operationally Required
En-Route Oceanic	RNAV-10,	RNP-4
En-Route Remote Continental	RNAV-10,	RNP-4
En-Route Continental	RNAV-2, RNAV-5	RNAV-1
TMA Arrival/Departure	Expand RNAV-1, or RNP-1	

Airspace	Nav. Specifications	Nav. Specifications where Operationally Required
	application Mandate RNAV-1, or RNP-1 in high density TMAs	
Approach	Expand RNP APCH with (Baro-VNAV) and APV Expand RNP AR APCH where there are operational benefits	

5.2.2. Mid-Term implementation targets

a) RNP APCH (with Baro-VNAV) or APV in 100% of instrument runways by 2016
b) RNAV-1 or RNP-1 SID/STAR for 100% of international airports by 2016
c) RNAV-1 or RNP-1 SID/STAR for 70% of busy domestic airports where there are operational benefits
d) Implementation of additional RNAV/RNP Routes as required

5.3. Summary of Long-Term key strategies (2017 and beyond)

Key strategies - The key strategies for instituting performance-based operations employ an integrated set of solutions.

a) Airspace operations will take advantage of aircraft capabilities, i.e. aircraft equipped with data communications, integrated displays, and FMS.
b) 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).
c) Strategic and tactical flow management will improve through use of integrated airborne and ground information exchange.
d) Ground-based system knowledge of real-time aircraft intent with accurate aircraft position and trajectory information available through data link to ground automation.
e) 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.
f) Overall system responsiveness achieved through flexible routing and well-informed, distributed decision-making.
g) Systems ability to adapt rapidly to changing meteorological and airspace conditions.
h) System leverages through advanced navigation capabilities such as fixed radius transitions, RF legs, and RNP offsets.
i) Increased use of operator-preferred routing and dynamic airspace.
j) Increased collaboration between service providers and operators.

k) Operations at the busiest airports will be optimized through an integrated set of capabilities for managing pre-departure planning information, ground-based automation, and surface movement.
l) RNP-based arrival and departure structure for greater predictability.
m) Ground-based tactical merging capabilities in terminal airspace.
n) Integrated capabilities for surface movement optimization to synchronize aircraft movement on the ground. Improved meteorological and aircraft intent information shared via data link.

6. Implementation strategy

6.1. General

6.1.1. This plan provides a high-level strategy for the evolution of navigation capabilities to be implemented in three time frames: near term (2008-2012), midterm (2013-2016), and Long term (2017 and Beyond). 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 continental operations. The section on Long-term initiatives discusses integrated navigation, communication, surveillance and automation strategies.

6.1.2. To avoid proliferation of new navigation standards, Tanzania will communicate any new operational requirements to ICAO ESAF.

6.2. Near Term, Mid Term and Long Term Key Tasks

The key tasks involved in the transition to performance-based navigation are:

a. Establish navigation service needs through the Long term that will guide infrastructure decisions and specify needs for navigation system infrastructure, and ensure funding for managing and transitioning these systems.

b. Define and adopt a national policy enabling additional benefits based on RNP and RNAV.

c. Identify operational and integration issues between navigation and surveillance, air-ground communications, and automation tools that maximize the benefits of RNP.

d. 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.

e. To support Civil/Military coordination and develop the policies needed to accommodate the unique missions and capabilities of military aircraft operating in civil airspace.

f. Harmonize the evolution of capabilities for interoperability across airspace operations.

g. Increase emphasis on human factors, especially on training and procedures as operations increase reliance on appropriate use of flight deck systems.

h. Facilitate and advance environmental analysis efforts required to support the development of RNAV and RNP procedures.

i. Maintain consistent and harmonized global standards for RNAV and RNP operations.

6.3. Near term strategy (2008-2012)

6.3.1. General

In the near-term, initiatives focus on investments by operators in current and new aircraft acquisitions, satellite based navigation and conventional navigation infrastructure. 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 of RNAV and RNP procedures. As demand for air travel continues to rise, choke points will develop and delays at major airports will continue to increase. RNAV and RNP procedures will help alleviate these problems. Continued introduction of RNAV and RNP procedures will not only provide benefits and savings to the operators but also encourage further equipage.

ANSPs as a matter of urgency must adapt new flight plan procedures to accommodate PBN operations. This particularly addresses fields 10 and 18.

Operators will need to plan to obtain operational approvals for the planned navigation specifications for this period. Operators shall acquaint themselves with Regional PBN Implementation Plans from other Regions to assess if there is a necessity for additional operational approvals.

6.3.2. En route

6.3.2.1. Oceanic and Remote Continental – N/A

6.3.2.2. Continental

For airspace and corridors requiring structured routes for flow management, Tanzania will review existing conventional and RNAV routes during transition to RNAV 10 or RNP 4.

6.3.3. Terminal Areas (Departures and Arrivals)

Where operationally feasible, Tanzania shall develop operational concepts and requirements for continuous descent arrivals (CDAs) based on FMS, Vertical Guidance and for applying time of arrival control based on RNAV and RNP procedures. This would reduce workload for pilots and controllers as well as increase fuel efficiency.

PBN SIDs and STARs would allow the following:

a. Reduction in controller-pilot communications;
b. Reduction of route lengths to meet environmental needs and reduce operational costs
c. Seamless transition from and to en-route entry/exit points;

d. Sequence departures to maximize benefits of RNAV and identify automation requirements for traffic flow management, sequencing tools, flight plan processing, and tower data entry activities.

6.3.4. Approach

6.3.4.1. The application of RNP APCH is expected to be implemented in the maximum possible number of aerodromes. To facilitate a transitional period, conventional approach procedures and conventional navigation aids shall be maintained for non PBN equipped aircraft during this term.

6.3.4.2. Tanzania shall promote the use of APV operations (Baro-VNAV or SBAS) to enhance safety of RNP approaches and accessibility of runways.

6.3.4.3. The application of RNP AR approach shall be limited to selected runways where obvious operational benefits can be obtained due to the existence of significant obstacles.

6.3.4.4. RNP approaches include APV implemented at all instrument runways at major regional airports and all non-instrument runways serving aircraft weighing greater than 5,700kg.

6.3.5. Summary of near term strategy (2008-2012)

Airspace	**Nav. Specifications**	**Action Office**
En-Route	RNAV 10, RNP 4	DANS
TMA Arrival/Departure	RNAV SIDs and STARs	DANS
Approach	RNP APCH with Baro-VNAV	DANS

6.3.6. Implementation Methods and Targets

Station	**Flight Phase**	**FACILITY**	**NAVSPECS**	**Action Office**	**Target date**	**ICAO Target**
HTDC	En-Route	Airways	RNAV 10/RNP 4	DANS	2012	
HTDA	Terminal	SIDS	RNAV	DANS	2012	100%
		STARS	RNAV	DANS	2012	100%
	Approach	RWY05	RNAV	DANS	2012	100%
		RWY23	RNAV	DANS	2012	100%
		RWY14	RNAV	DANS	2012	100%
		RWY 32	RNAV	DANS	2012	100%
HTKJ	Terminal	SIDS	RNAV	KADCO	2012	100%
		STARS	RNAV	KADCO	2012	100%
	Approach	RWY 09	RNAV	KADCO	2012	100%
		RWY 27	RNAV	KADCO	2012	100%
HTZA	Terminal	SIDS	RNAV	DANS	2012	100%
		STARS	RNAV	DANS	2012	100%
	Approach	RWY 18	RNAV	DANS	2012	100%
		RWY 36	RNAV	DANS	2012	100%
HTMW	Terminal	SIDS	RNAV	DANS	2012	100%
		STARS	RNAV	DANS	2012	100%
	Approach	RWY12	RNAV	DANS	2012	100%

Station	Flight Phase	FACILITY	NAVSPECS	Action Office	Target date	ICAO Target
		RWY30	RNAV	DANS	2012	100%
HTAR	Terminal	SIDS	RNAV	DANS	2012	100%
		STARS	RNAV	DANS	2012	100%
	Approach	RWY 09	RNAV	DANS	2012	100%
		RWY 27	RNAV	DANS	2012	100%

Note – HTKJ and HTDA RNAV (GNSS) to be reviewed and re-designated to RNP APCH including BARO VNAV.

6.4. Medium term strategy (2013-2016)

6.4.1. In the midterm, 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 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.

6.4.2. The midterm 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. To achieve efficiency and capacity gains partially enabled by RNAV and RNP, Tanzania will enhance communications and surveillance capability.

Implementation of ADS-B will expand or augment surveillance coverage so that track spacing and longitudinal separation can be optimized where needed (e.g., in non-radar airspace)..

6.4.3. En route

6.4.3.1. Oceanic and Remote Continental: Not applicable

6.4.3.2. Continental

The major ATS routes in the Dar es Salaam FIR are predominantly east/west and north/south. Considering the type of ground NAVAIDS provided it is not practicable to perform RNAV. Continental RNAV routes based on GNSS will be developed in order to improve enroute navigation in the lower and upper airspaces.

6.4.3.3. Implementation

By the end of the midterm other benefits of PBN such as flexible procedures to manage the mix of faster and slower aircraft in congested airspace and use of less conservative PBN requirements will have been achieved.

6.4.3.4. Automation for RNAV and RNP Operations

By the end of the midterm enhanced en-route automation will allow the assignment of RNAV and RNP routes based upon specific knowledge of 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 recognize aircraft capability and to match the aircraft to dynamic routes or procedures, thereby helping appropriately equipped operators to maximize 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 maximizing the capacity of airspace.

6.4.4. Terminal Areas (Departures and Arrivals)

6.4.4.1. Terminal procedures

During this period, either Basic RNP-1 or 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. With RNAV-1 operations as the predominant form of navigation in terminal areas by the end of the midterm, Tanzania will have the option of removing conventional terminal procedures that are no longer expected to be used.

6.4.4.2. 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 maneuvers 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 PBN and flow management tools. Flights arriving and departing busy terminal areas will follow automation-assigned PBN routes.

6.4.5. Approach

In the midterm, implementation priorities for instrument approaches will be based on RNP and RNAV. RNP AR APCH may be included if need arises especially in airports located in mountainous areas.

6.4.6. Helicopter operations

Existing helicopter operation procedures will continue to be used. PBN procedures will be implemented as may be required.

6.4.7. Summary of medium term strategy (2013-2016)

Airspace	**Nav. Specifications**	**Action Office**
En-route Domestic	RNAV 10 or RNP 4	DANS
Terminal SIDs/STARs	RNAV-1	DANS
Approach	RNP APCH	DANS

6.4.8. Implementation Methods and Targets

Aerodrome	Airspace	NAVSPECS	Action Office	Target date	ICAO Target
HTMB	Terminal	SIDS	RNAV	DANS	100%
		STARS	RNAV	DANS	100%
	Approach	RWY 09	RNAV	DANS	100%
		RWY 27	RNAV	DANS	100%
HTTB	Terminal	SIDS	RNAV	DANS	100%
		STARS	RNAV	DANS	100%
	Approach	RWY13	RNAV	DANS	100%
		RWY31	RNAV	DANS	100%
HTKA	Terminal	SIDS	RNAV	DANS	100%
		STARS	RNAV	DANS	100%
	Approach	RWY16	RNAV	DANS	100%
		RWY34	RNAV	DANS	100%
HTMT	Terminal	SIDS	RNAV	DANS	100%
		STARS	RNAV	DANS	100%
	Approach	RWY01	RNAV	DANS	100%
		RWY19	RNAV	DANS	100%
HTMP	Terminal	SIDS	RNAV	DANS	100%
		STARS	RNAV	DANS	100%
	Approach	RWY09	RNAV	DANS	100%
		RWY27	RNAV	DANS	100%
HTDO	Terminal	RWY10	RNAV	DANS	100%
			RNAV	DANS	100%
	Approach	RWY28	RNAV	DANS	100%
HTPE	Terminal		RNAV	DANS	100%
			RNAV	DANS	100%
	Approach	RWY03	RNAV	DANS	100%
		RWY21	RNAV	DANS	100%
HTTG	Terminal	SIDS	RNAV	DANS	100%
		STARS	RNAV	DANS	100%
	Approach	RWY06	RNAV	DANS	100%
		RWY24	RNAV	DANS	100%
HTBU	Terminal	SIDS	RNAV	DANS	100%
		STARS	RNAV	DANS	100%
	Approach	RWY13	RNAV	DANS	100%
		RWY31	RNAV	DANS	100%
HTMA	Terminal	SIDS	RNAV	DANS	100%
		STARS	RNAV	DANS	100%

Aerodrome	Airspace	NAVSPECS	Action Office	Target date	ICAO Target
	Approach	RWY15	RNAV	DANS	100%
	Approach	RWY33	RNAV	DANS	100%
HTLM	Terminal	SIDS	RNAV	DANS	100%
		STARS	RNAV	DANS	100%
	Approach	RWY12	RNAV	DANS	100%
	Approach	RWY30	RNAV	DANS	100%

6.5. Long term strategy (2017 and beyond)

The Long-term environment will be characterized 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, Tanzania and key Stakeholders need an operational concept that exploits the full capability of the aircraft in this time frame.

6.5.1. Long Term Key Strategies (2017 and Beyond)

Airspace operations in the Long 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.

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 18.data communications) of flight intent from the flight deck to the ground automation.

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 minimize 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).

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.

System wide information exchange will enable real-time data sharing of the airspace system 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.

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. 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 standardized FMS functionalities and consistent levels of crew operation of the FMS is integral to the success of this Long-term strategy.

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.

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. Uniform use of RNP for arrivals and departures at busy airports will optimize 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. 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 synchronize 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.

6.5.2. Summary of Long Term Key Strategies (2017 and Beyond)

The key strategies for instituting performance-based operations employ an integrated set of solutions.

a) Airspace operations will take advantage of aircraft capabilities, i.e. aircraft equipped with data communications, integrated displays, and FMS.

b) 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).
c) Strategic and tactical flow management will improve through use of integrated airborne and ground information exchange.
d) Ground-based system knowledge of real-time aircraft intent with accurate aircraft position and trajectory information available through data link to ground automation.
e) 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.
f) Overall system responsiveness achieved through flexible routing and well-informed, distributed decision-making.
g) Systems ability to adapt rapidly to changing meteorological and airspace conditions.
h) System leverages through advanced navigation capabilities such as fixed radius transitions, RF legs, and RNP offsets.
i) Increased use of operator-preferred routing and dynamic airspace.
j) Increased collaboration between service providers and operators.

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

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

6.5.3. Key Research Areas

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

a) **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?

b) **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 Long-term strategies such as real-time exchange of flight deck data?

c) **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 and trade-offs associated with different levels of automation?

To what extent can conflict detection and resolution be automated for terminal ATC operations?

d) **Procedures**

How can time of arrival control be applied effectively to maximize 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?

e) **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?

GLOSSARY

3D	Three-Dimensional
4D	Four-Dimensional
ADS-B	Automatic Dependent Surveillance-Broadcast
ADS-C	Automatic Dependent Surveillance-Contract
ATC	Air Traffic Control
CDA	Continuous Descent Arrival
CNS	Communications, Navigation, Surveillance
EFVS	Enhanced Flight Visibility System
GA	General Aviation
GBAS	Ground-Based Augmentation System
GLS GNSS	(Global Navigation Satellite System) Landing System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
LNAV	Lateral Navigation
LPV	Localizer Performance with Vertical Guidance
NAS	National Airspace System
NAVAID	Navigation Aid
NM	Nautical Miles
PBN	Performance Based Navigation
RCP	Required Communications Performance
RF	Radius-to-Fix
RNAV	Area Navigation
RNP	Required Navigation Performance
RNPSORSG	Required Navigation Performance and Special Operational Requirements Study Group 22.
RSP	Required Surveillance Performance
SAAAR	Special Aircraft and Aircrew Authorization Required
SID	Standard Instrument Departure
STAR	Standard Instrument Arrival
VLJ	Very Light Jet
VNAV	Vertical Navigation
WAAS	Wide Area Augmentation System