ICAO

CAPACITY & EFFICIENCY

Air Navigation Report

2015 Edition

A Coordinated, Needs-based Approach to Air Navigation Evolution

The air transport industry plays a major role in world economic activity. One of the key elements to maintaining the vitality of civil aviation is to ensure safe, secure, efficient and environmentally sustainable operations at the global, regional and national levels.

A specialized agency of the United Nations, the International Civil Aviation Organization (ICAO) was created in 1944 to promote the safe and orderly development of international civil aviation throughout the world.

ICAO sets the Standards and Recommended Practices (SARPs) necessary for aviation safety, security, efficiency and environmental protection on a global basis. ICAO serves as the primary forum for co-operation in all fields of civil aviation among its 191 Member States.

In the context of an assured safety environment under its first Global Aviation Safety Plan (GASP), ICAO seeks to ensure the delivery of efficient and comprehensive air navigation services under its complementary Global Air Navigation Plan (GANP). The Organization works constantly to address and enhance global air navigation capacity and efficiency through the following coordinated activities:

- **Policy and Standardization** initiatives.
- **Monitoring** of key performance trends and indicators.
- Performance **Analysis**.
- **Implementing** programmes to address performance issues.

Developed to reflect and align the agreed series of technologies, procedures and system-wide capabilities needed to meet the significant capacity challenges of the next 15 years, the GANP organizes these requirements into a flexible series of performance improvements and timelines. These were agreed to through ICAO during the 2011–2013 timeframe by States, airline and airport operators, civil air navigation service providers, aircraft manufacturers and many other stakeholders in the global aviation system, and have become known as the ICAO aviation system block upgrades (ASBUs).

> "In all of its coordinated activities, ICAO always strives to achieve a balance between the need for increased capacity and efficiency and maintaining aviation safety at an acceptable level."

This report provides updates on capacity and efficiency indicators including performance-based navigation approaches issued in 2014, taking as a benchmark the analysis in previous report.

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All maps rendered in this document are notional, may not reflect actual boundaries agreed by the United Nations and should not be used for navigational purposes.

Note:

All performance-based navigation indicators throughout the report relate to international aerodromes only, as published in the regional air navigation plans.

Contents

Executive Summary

Traffic Overview

Some 3.2 billion passengers used air transport for their business and tourism needs in 2014, according to preliminary figures on scheduled services. The number of annual total passengers carried was up approximately 5% compared to 2013 and is expected to reach over 6.4 billion by 2030, based on current projections.

Aircraft departures reached 33 million globally during 2014, establishing a new record and surpassing the 2013 figure by roughly one million flights. Solid global economic growth and improving world trade helped world scheduled passenger traffic grow at a rate of 5.9% in 2014 (expressed in terms of revenue passenger-kilometres or RPKs), compared to 5.5% in 2013.

The Asia/Pacific region was the world's largest air travel market in 2014, with a 31% share in terms of world RPKs. The second and third largest air travel markets were Europe and North America, representing 27% and 25%, respectively. The Middle East Region, accounting for 9% of world RPKs, recorded the fastest growth rate at 12.8%. The Latin America and Caribbean Region increased by a solid 5.9% while African growth registered in at 1.5%.

International Passenger Traffic

International scheduled passenger traffic grew by 6.3% in 2014, up from the 5.2% recorded in 2013. With recovery in the Eurozone economy, European traffic increased by 5.7% and accounted for the largest share of international RPKs with 38%. Asia/Pacific had the second largest share with 27%, growing by 5.8%. North America was also up by 3.1%, in line with its improving economic conditions.

With its combined economic strength and airline network expansion, the Middle East recorded the highest international passenger traffic growth at 13.4% compared to 2013. The Latin America/Caribbean region meanwhile grew by a solid 6.2% despite weakness in some of its economies, and carriers in Africa experienced the slowest growth rate of 1.7%.

Domestic Passenger Traffic

Scheduled domestic passenger traffic increased by 5.1% compared to 2013, with North America and the Asia/Pacific accounting for a combined 82% of worldwide domestic traffic (44% for North America, 38% for Asia/Pacific). The Asia/Pacific domestic market experienced the fastest growth, 7.9% compared to 2013, driven mainly by Chinese airlines which accounted for approximately 60% of the region's total domestic traffic.

Capacity

Overall air transport capacity, expressed in available seat-kilometres (ASKs), increased globally by 5.7% in 2014. The overall passenger load factor was relatively stable compared to 2013 at 79.5%. Carriers in North America achieved the highest passenger load factor in 2014, 83.5%, followed by European carriers at 80.4%.

Table: Regional Passenger Traffic and Capacity Growth, market shares and load factors in 2014*

	RPKs						ASKs	LFs
	International		Domestic		Total		Total	Total
	Traffic Growth	Market Share	Traffic Growth	Market Share	Traffic Growth	Market Share	Capacity Growth	Load Factors
Africa	↑ 1.7%	3%	↑ 0.6%	1%	↑ 1.5%	2%	↑ 2.1%	68.3%
Asia and Pacific	↑ 5.8%	27%	↑ 7.9%	38%	↑ 6.7%	31%	↑ 7.2%	77.4%
Europe	↑ 5.7%	38%	↑ 5.8%	9%	↑ 5.7%	27%	↑ 5.2%	80.4%
Latin America and the Caribbean	↑ 6.2%	4%	↑ 5.6%	7%	↑ 5.9%	5%	↑ 5.3%	77.8%
Middle East	↑ 13.4%	14%	↑ 3.6%	1%	↑ 12.8%	9%	↑ 12.5%	77.7%
North America	↑ 3.1%	14%	↑ 2.9%	44%	↑ 3.0%	25%	↑ 2.6%	83.5%
World	**↑ 6.3%**	**100%**	**↑ 5.1%**	**100%**	**↑ 5.9%**	**100%**	**↑ 5.7%**	**79.5%**

RPKs: Revenue Passenger Kilometres ASKs: Available Seat-kilometres LFs: Passenger Load Factors

Air Freight

World scheduled freight traffic, measured in freight tonne-kilometres (FTKs), grew strongly by 4.6% in 2014, a rebound from the 0.4% growth rate registered in 2013. This is a reflection of improvement in world trade. The Asia/Pacific region was the world's largest air freight market in 2014 with a 40% share in terms of world FTKs. Europe and North America came in at 22% and 21%, respectively, while Middle Eastern airlines recorded the fastest growth in freight traffic in 2014 with a growth of 11.3%.

Industry Trends

The world's major aircraft manufacturers delivered approximately 1 000 new commercial aircraft by the end of 2014, with orders recorded for over 2 000 more. Together with improved air traffic flow management (ATFM) and the expanded use of performance-based navigation (PBN), these environmentally friendly aircraft will contribute positively to the sustainability of air transport development.

** Preliminary figures covering scheduled commercial services only. Statistics applicable to traffic by region of airline domicile.*

Regional Targets

Regional Dashboards

Reporting on a global scale is intrinsically complex but serves to develop consensus on the status of global initiatives, allowing for direct feedback on the implementation of the Global Plans. Measuring performance at the regional level is just as important, however, as it allows for a more in-depth look at how local approaches and variations affect each safety and air navigation environment. This type of feedback is key to how ICAO's regional offices prioritize their resources and work programmes towards desired operational results.

The Performance Dashboards shown below present up-to-date regional implementation results, highlighting what States and groups of States are achieving in collaboration with their respective Planning and Implementation Regional Groups (PIRGs) and Regional Aviation Safety Groups (RASGs). Their ultimate intention, besides ICAO's basic measurement, accountability and transparency goals, is to help motivate aviation groups and stakeholders to continue to participate in and improve upon the applicable cooperative programmes being implemented at the regional level.

The dashboards are available on the ICAO public safety and air navigation websites, as well as on each Regional Office website.

Performance Targets

ICAO Member States were invited to adopt regional safety objectives and targets through their respective regional air navigation bodies. As of March 2015, all air navigation regions have adopted targets through the form of resolutions. Those resolutions can be found on the ICAO public safety and air navigation website.

Air Nav. Region	Regional Office	Air Navigation
AFI	ESAF WACAF	**ANS Performance Indicators for Africa** (APIRG/19–October 2013)
MID	MID	**MID Region Air Navigation Strategy** (MSG/4–November 2014)
ASIA/PAC	APAC	**APANPIRG Priorities and Targets** (APANPIRG/25–September 2014)
NAM **CAR**	NACC	**Port-of-Spain Declaration** (NACC/DCA/5–April 2014)
SAM	SAM	**BOGOTA Declaration** (RAAC/13–December 2013)
EUR	EUR/NAT	**EURASBU Implementation Plan** (EANPG/55–November 2013)
NAT		**NAT Service Development Roadmap** (NAT-SPG/49–June 2013)

Regional targets were defined for the following priorities:

- Implementation of performance-based navigation at international aerodromes (PBN)
- Utilization of air traffic flow management (ATFM) systems
- Implementation of aeronautical information management (AIM)
- Implementation of ground–ground digital coordination/transfer (GGDCT)
- Continuous descent and climb operations (CCO/CDO)
- Fuel savings/CO2 emissions reduction due to ASBU implementation

The rest of this report provides details of the levels of implementation for these objectives.

Global Air Navigation Priorities

Performance-based Navigation (PBN)

The implementation of PBN continues to be the global aviation community's highest air navigation priority, mainly because of the significant benefits it offers to all aviation stakeholders: improved safety through more straight-in instrument approaches with vertical guidance, increased airspace capacity, increased airport accessibility, more efficient operations, reduced infrastructure costs and reduced environmental impact. The High-level Safety Conference (HLSC) 2015 further confirmed the importance for States to expedite PBN implementation.

In addition, PBN is a key enabler for the implementation of many of ICAO's Aviation System Block Upgrade (ASBU) performance improvement areas. It is an essential component to improving airport operations through ASBU modules B0-APTA — Optimization of Approach Procedures Including Vertical Guidance and B1-APTA — Optimized Airport Accessibility. PBN also facilitates more efficient flight paths through trajectory-based operations, supporting the application of modules B0-CDO, B1-CDO, B0-CCO, and B0-FRTO, all of which contribute to significant efficiency, capacity and environmental benefits.

This section provides a global update on PBN implementation. Assembly Resolution A37-11 established specific PBN implementation or performance targets for States to achieve. This section therefore provides an assessment, including trends, on the global progress against those targets. Also outlined are ICAO initiatives implemented over the past year to assist States with PBN implementation as well as the objectives planned for next year. Finally, specific PBN success stories are identified to highlight the actual benefits being achieved by many States, providing further validation of the importance of PBN implementation.

PBN Implementation Targets and Progress

ICAO Assembly Resolution A37-11

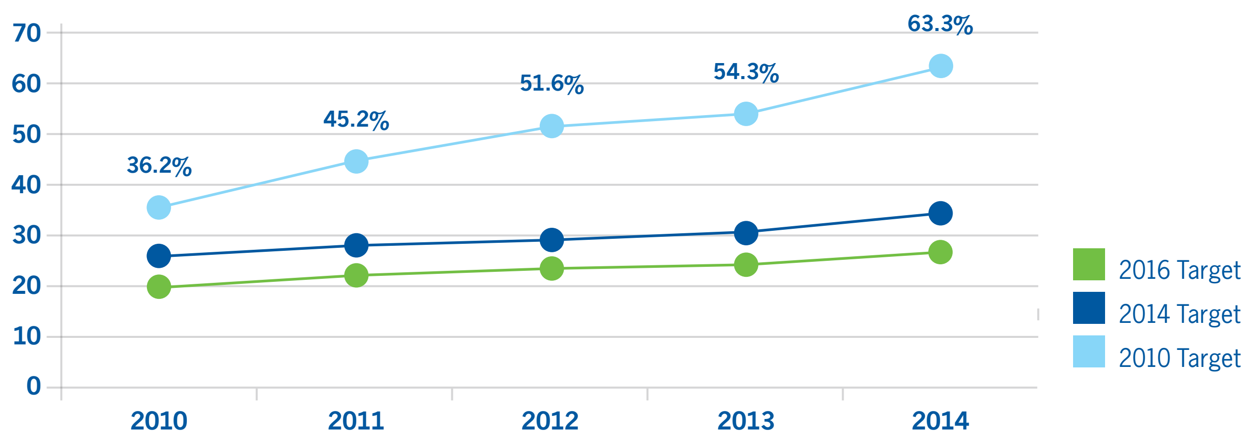
Assembly Resolution A37-11 requests States to complete PBN implementation plans as a matter of urgency and creates a strong commitment for the full implementation of PBN approaches by 2016 with an intermediate objective of 70% implementation by the end of 2014.

Progress has been made towards meeting these targets and the trend is generally positive as it shows an increase of 8% in 2014. However, as of January 2015, only 43.6% of ICAO Member States have implemented PBN approaches on their international instrument runway ends. States should be making a concerted effort to meet the 2016 target of 100% implementation.

It has been acknowledged that to fully realize the benefits of the Assembly Resolution, some issues relating to implementation need to be resolved. One element is the lack of full implementation of the WGS-84 coordinate system, a fundamental prerequisite to PBN operations. Furthermore, the insufficient number of trained *Procedures for Air Navigation Services — Aircraft Operations* (Doc 8168, PANS-OPS) specialists has contributed to the low implementation rate of PBN instrument approach procedures.

ICAO is providing guidance material, new products and services and identifying qualified procedure design organizations in order to expedite the implementation of elements that are integral to the PBN concept.

Figure 1: Percentage of States Meeting the Resolution Targets for Applicable Years



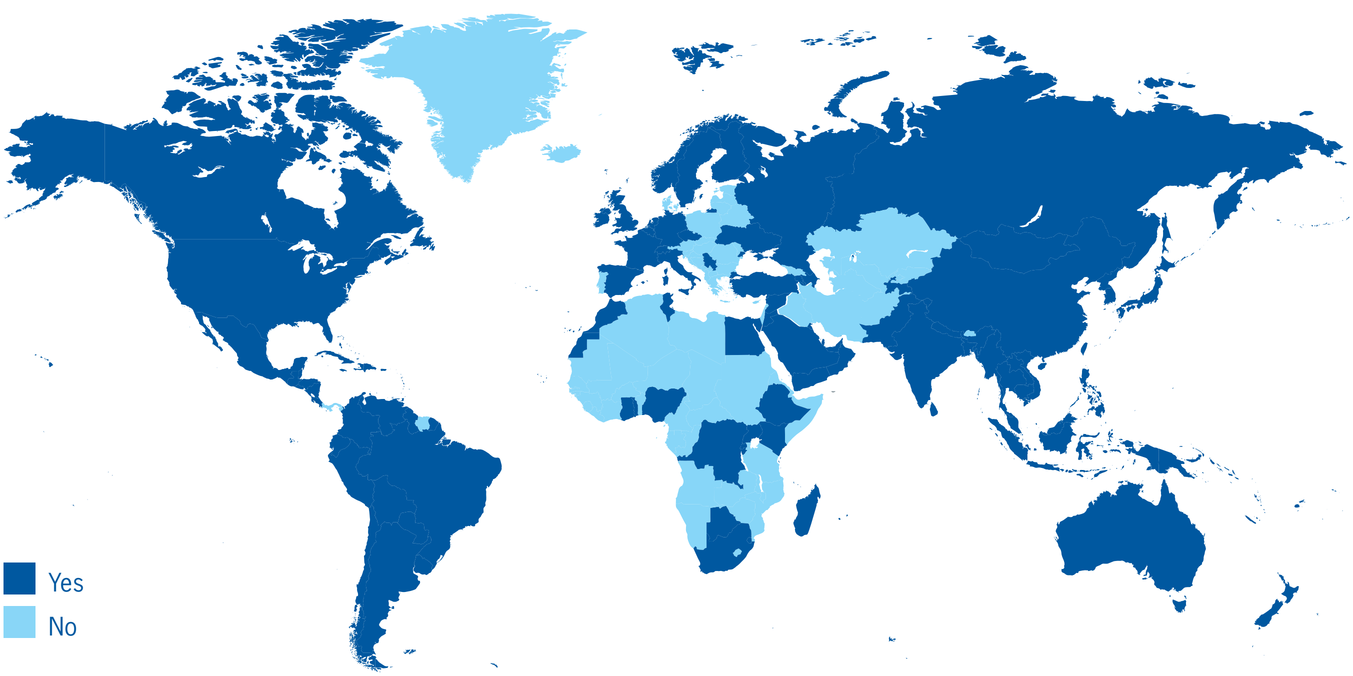
PBN Implementation Plans – Status

PBN implementation plans are an essential tool to assist the State aviation community to execute a smooth transition to RNAV and RNP. They help realize the full safety, economic and environmental benefits of PBN and serve to guide a synchronized investment in new technology and infrastructure.

As of the end of 2014, 105 States (55%) have committed to PBN by publishing a State PBN Implementation Plan as shown in Figure 2. Compared to 2013, the increase in number of PBN implementation plans is low. Therefore, States are urged to address the issues that prevent the development and publication of a State PBN Implementation Plan.

55% of ICAO Member States have published a PBN Implementation Plan

Figure 2: Global Status of PBN Implementation Plans (Based on ICAO Regional Offices Inputs)



PBN Approaches

The first edition of the Global Air Navigation Report monitored the global implementation of PBN at all airports with ICAO 4-letter codes. A significant number of airports of various sizes were included. This showed how beneficial PBN implementation can be in various and diverse environments, particularly where little or no conventional navaid infrastructure is in place.

The PBN approach procedures considered in this report are those related to runways at international aerodromes as defined in the ICAO Regional Air Navigation Plans (ANPs). Whilst this is a change to the methodology used previously, it promotes harmonization across the ICAO Regions in the way international aerodromes are accounted for. As a result, fewer airports have been examined and different statistics in terms of PBN implementation have been observed, compared to last year's analyses. The two sets of figures (2013 and 2014) do not consider the same definition of an airport and are therefore not directly comparable.

ICAO's PBN Concept was introduced through the publication of the ICAO *Performance-based (PBN) Manual* (Doc 9613) in 2008. Since then, PBN has been increasingly implemented in the terminal areas in the form of RNP (LNAV, LNAV/VNAV, LPV) or RNP AR approaches[1]. As of January 2015, 55.8% of all instrument runways have at least one PBN approach procedure defined (Figure 3), which represents an increase of 3.9 percentage points compared to 2013.

55.8% (+3.9) of all instrument runways have at least one PBN approach procedure

Figure 3: Global PBN Implementation Growth 2010-2014 (% of PBN Runways for World)

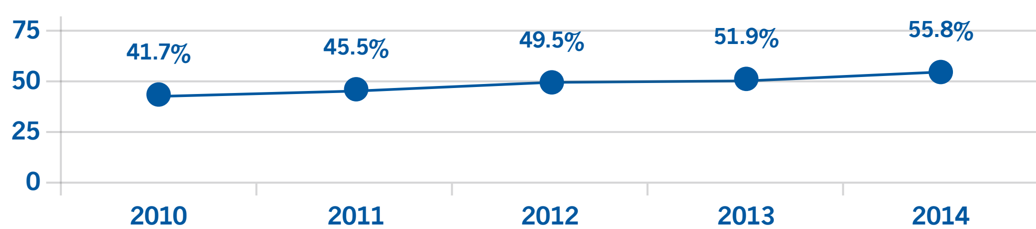
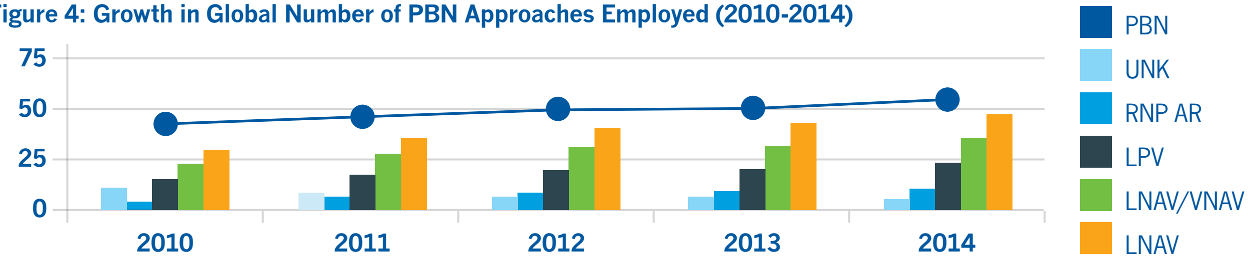


Figure 4 shows that LNAV approach procedures are the ones mostly implemented (46.7%), followed by LNAV/VNAV (35.3%), LPV (23.2%) and RNP AR (11.1%). Some approach procedures are classified as "unknown" when no information has been provided (6.8%).

Implementation of all PBN approach types continues to increase

Figure 4: Growth in Global Number of PBN Approaches Employed (2010-2014)



[1] *The unit of measurement for monitoring implementation is the runway which is defined as "PBN runway" when at least one PBN approach procedure is published.*

PBN SID/STAR Procedures

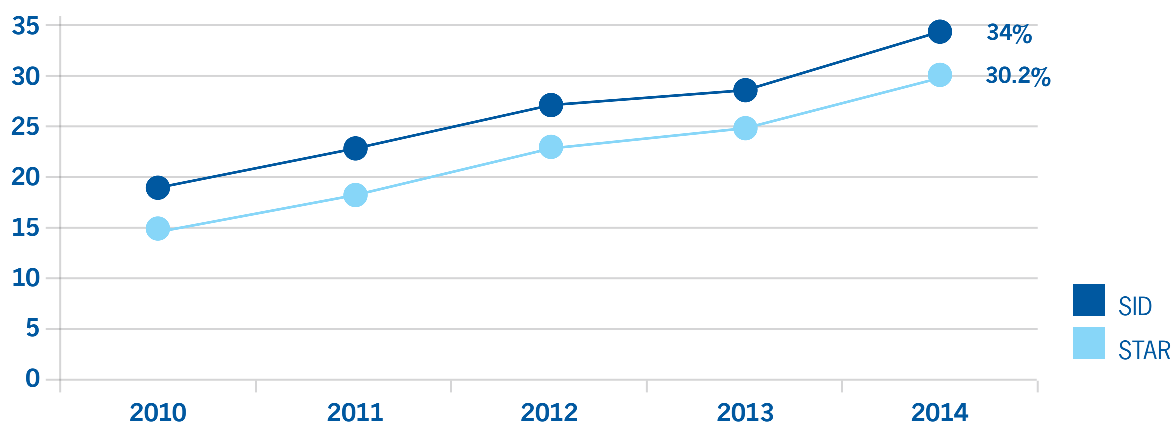
Establishment of PBN structured arrival and departure flows enables more accurate navigation, allows for more efficient flights as well as for more flexible routing and facilitates improved sequencing resulting in reduced delays.

PBN implementation has been monitored in terms of the growth of PBN Standard Instrument Departures (SIDs) and Standard Terminal Arrival (STARs) procedures at international instrument runways.

34% of all runways have at least one PBN SID procedure published, and 30.2% have a PBN STAR procedure. The trend is growing constantly.

1/3 of all international instrument runways have PBN SID/STAR procedures available

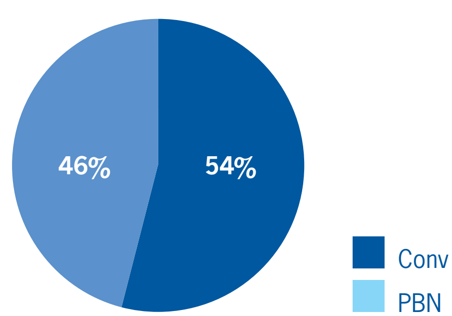
Figure 5: PBN SID and STAR Growth 2010-2014



PBN En route

Airspace redesigns continue to grow as stakeholders demand improvements in airspace capacity and operational efficiency. Implementing more PBN routes in the en route structure leads to shorter distances flown, user preferred routes, and closer route spacing. Figure 6 shows a global comparison of PBN routes versus conventional routes. This reflects an 8% growth in PBN routes since 2013.

2014 Route Data
Figure 6: PBN versus Conventional Route Types, Globally



ICAO support to PBN Implementation

Last year's activities

PBN GO Teams

The ICAO-IATA PBN GO Teams have been extremely successful in helping States with PBN Implementation. The first phase (2010–2012) assessed the status of PBN plans, existing PBN operational approval processes, airspace concepts, CNS infrastructure, ATM, CDO implementation, PBN instrument flight procedures and training. The GO Teams visited locations in all of the seven ICAO Regions. The second phase commenced in 2013 and concentrated on training in airspace design and operations approval. In 2014, visits were conducted to China and the United Arab Emirates.

The GO Team concept has now concluded and been replaced with customized ICAO products and services aimed at helping States with their specific PBN implementation challenges.

Establishment of Customized PBN Products and Services

Since ICAO first began raising PBN awareness, much has been learned about the needs of States and stakeholders in terms of PBN implementation assistance. ICAO has therefore created and structured the new PBN products and services into six specific categories to assist States with implementation and thus help them meet the targets of A37–11. More information on the products and services can be found at http://www.icao.int/safety/pbn/Pages/PBN-Products-and-Services.aspx.

Updated PBN Implementation Kit (iKit)

PBN implementation involves many different stakeholders and processes from airborne equipment to airspace infrastructure development. Standards, procedures and guidance that support implementation are covered in various ICAO documents.

The PBN iKit was developed to provide the main stakeholders (executives, regulators, air navigation service providers, aircraft operators and manufacturers) with essential explanatory information, practical documentation and guidance material on implementing PBN in relation to their area. In 2014, a revised and updated iKit was released with new information as a result of recent changes to ICAO provisions. The PBN iKit is available at http://www.icao.int/safety/pbn/Pages/default.aspx

New PBN Instrument Procedure Design Criteria

New PANS-OPS criteria became applicable supporting the new RNP 2, RNP 0.3 and Advanced RNP navigation specifications as well as helicopter point-in space (PinS) approach and departure operations.

New SARPs and guidance material for regulatory oversight of flight procedure design services and new design criteria that allows for transition from RNAV or RNP to ILS/MLS/GLS intermediate segments and transition from ILS/MLS/GLS to RNAV or RNP missed approach have been proposed for 2016 applicability, significantly improving operational efficiency in the terminal area.

African Flight Procedures Programme (AFPP)

Although the decision to establish the AFPP was made in 2013, the programme was not officially launched until June 2014. Today, 27 African States are participating and a Steering Committee has been established to oversee the financial contributions and work plan activities. The AFPP provides instrument procedure design support including training on regulatory processes, validation, and quality assurance as well as PBN training for ATC, ATM and Operations approval personnel.

Outlook

PBN remains the primary air navigation priority, as highlighted by the High-level Safety Conference (HLSC) 2015. The focus of the programme now is on developing the tools and guidance material to assist States with implementation of PBN routes and procedures.

To further this objective, ICAO will investigate the possibility of new partnerships with the aviation industry and other international organizations. These partnerships will focus on the collaborative provision of products and services to assist not only States but all aviation stakeholders with addressing their PBN challenges. As well, new iKits planned for 2016 will include additional guidance material on the use of PBN in both the terminal and en-route environments.

This coming year will see a greater emphasis on increasing industry knowledge and understanding of PBN and, to this end, new training material, including Computer Based Training (CBT) packages, are being developed. Clearer guidance material for operational staff will also be produced.

Regulatory oversight is another area identified by the HLSC as requiring significant development work. Guidance material will be produced on the recommended structure and functions of an effective State regulatory authority.

Work is also progressing on the development of new and improved PBN instrument procedure design criteria, including SBAS/Baro-VNAV approaches and RNP AR departures, which will result in the uniform application of procedures that allow more efficient utilization of modern PBN systems.

A new version of the *Performance-based Navigation (PBN) Operational Approval Manual* (Doc 9997) will be published in 2015 to include approval processes and job aids for the new PBN navigation specifications of RNP 2, RNP 0.3 and Advanced RNP (A-RNP). A second update will follow later on incorporating the changes resulting from the move away from specific approvals for "general" PBN operations, which is designed to facilitate PBN as the normal means of navigation.

Finally, the PBN Study Group, re-instated last year, will continue to work on areas in need of development, including RNP AR departure specifications, the use of RF legs in the terminal area and FRT en route and the options for reversionary navigation in the event of a GNSS outage. Coordination with other ICAO panels will ensure the PBN study group is involved in areas which require their particular expertise. Of particular interest is the development of the Concept of Operations for the Guided Visual Approach which is being led by the Flight Operations Panel. This panel is also helping to develop the concept of "Complex" PBN procedures, in line with the changes to specific approvals for PBN mentioned above.

Success Stories

Thailand

In 2013, Thailand had established unidirectional RNAV5 routes connecting Phuket-Bangkok (Y5 Route) and Bangkok-Chiang Mai (Y6 and Y7 Routes). In June 2014, Thailand established five additional unidirectional RNAV5 routes connecting Bangkok with southern destinations:

- Y8 – Bangkok-Phuket;
- Y9, Y10 – Bangkok-Hat Yai-Kuala Lumpur; and
- Y11, Y12 – Bangkok-Singapore

The unidirectional routes are designed to increase airspace efficiency based on the PBN and flexible use of airspace (FUA) concepts. Moreover, these routes were created to reduce aircraft fuel consumption and greenhouse gas emissions, as well as to enhance safety and improve flow capacity of air traffic operations between Bangkok and major cities in the southern part of Thailand, plus other international destinations south of Thailand.

PBN Tibet RNP AR

In order to improve the overall airspace efficiency of Kathmandu and allow aircraft to circumnavigate the Himalayas as they descend in a safe and efficient manner, the Civil Aviation Administration of Nepal (CAAN) worked with its partners (Tibet Airlines and Airbus ProSky) to design and validate RNP AR procedures that reduce the Flight Path Angle at final approach from 5.31% to 2.8 degrees. This has significantly enhanced safety during the landing phase.

Peruvian Airspace PBN Implementation

In 2013, the Directorate General of Civil Aviation of Peru undertook a major project to reorganize airspace and implement PBN in Peruvian Airspace. The project, named PROESA, included the participation of aircraft operators, stakeholders and the ATM community.

The first stage was implemented on 24 July, 2014 and involved new and amended routes in the upper and lower network, reorganization of main domestic flows, as well as new PBN SIDs and STARs at the major terminal areas. The project benefits included:

- Implementation of unidirectional RNAV 5 parallel routes (based on GNSS) in the main local traffic flows, minimizing the possibility of opposite faced flights and enhancing en route operations.
- More than 50 new RNAV1/RNP1 SIDs and STARs procedures at Arequipa, Chiclayo, Cuzco, Lima, Piura, Pucallpa and Trujillo have achieved track mile reductions and enabled CCO and CDO.
- RNP-AR approach procedures facilitated access to highland airports surrounded by mountains as well as the start of night operations, resulting in a significant increase in tourism.
- One-month fuel savings of 361 400 kg, corresponding to 184 300 kg to international flows and 177 100 kg to domestic flows.
- Annual fuel savings of 4 336 800 kg obtained as a result of airspace optimization by applying PBN; and
- A total reduction of approximately 264 in air miles flown, corresponding to a reduction of 13 704 tons of CO2 emissions per year.

Implementation of PBN procedures at Russian airports

The plan for implementation of PBN procedures at Russian airports is part of the “Performance-based Navigation (PBN) Implementation Plan for the Airspace of the Russian Federation”. According to the plan, before the end of 2016 and for subsequent years, PBN procedures will be introduced at 68 Russian airports (157 landing/take-off directions).

For example, at Sochi airport, the recent implementation of PBN played an important role in addressing the huge increase in air traffic during the Olympic Games.

At the end of August 2014, GNSS RNAV STARs and SIDS were published in the AIP for 26 airports (68 takeoff/landing directions). Non-precision GNSS (LNAV)-approach procedures were published for 23 airports (58 landing directions). GLS procedures were published for 4 airports (10 landing directions) and in the near future the number of airports and landing directions for which GLS procedures are published is expected to increase, rapidly.

At some airports, it is planned to introduce RNP AR APCH procedures to enhance operational capabilities of airports (lowering minima for landings, departures and missed approaches in the direction of areas with complex terrain, as well as establishment of flight patterns to avoid flying over residential areas and in restricted flight areas).

PBN STAR in Bristol UK

Bristol is the first major UK airport to introduce new RNAV1 Performance-based Navigation Standard Terminal Arrival Routes (STARs) that use satellite navigation, coupled with the latest technology fitted to aircraft, to replace traditional ground beacons and landing systems.

The new STARs are part of a project to update the UK's airspace system, much of which was designed over 40 years ago. Since then, there has been a huge growth in demand for flying, changes in technology and greater environmental concerns.

The new routes apply to aircraft approaching from the south and have been designed to closely replicate existing tracks, but with greater precision than was previously possible. Approaches from the west have also been designed to take aircraft over the Severn Estuary, reducing noise disturbance to communities along the coastline.

United States: NEXTGEN Upgrade for Washington Airspace

The Federal Aviation Administration (FAA) announced that the Washington, D.C. Metroplex is the first in the nation to have three state-of-the-art, satellite-based highways in the sky running side by side, each dedicated to one of the three major airports in the region.

The three parallel optimized profile descents (OPD) enable aircraft serving the capital area's three major airports from the northwest to descend from cruising altitude to the runway in a smooth, continuous arc instead of the traditional staircase descent. This saves time for passengers, while reducing fuel and carbon dioxide emissions. The three airports benefitting from the NextGen arrivals are Baltimore/Washington International Thurgood Marshall Airport, Dulles International Airport and Ronald Reagan Washington National Airport.

Estimates predict airlines will burn at least 9.5 million fewer kg (2.5 million gallons) of fuel each year in the skies above Washington, while emitting at least 25 000 fewer metric tons of carbon dioxide. Using the Environmental Protection Agency's energy calculator, this is the equivalent of annual greenhouse gas emissions from 5 263 passenger vehicles or 8 961 tons of waste taken to landfills.

By improving traffic flow to the three major airports, the D.C. Metroplex initiative, a collaborative effort involving American, Southwest, United and labour unions, also enhances the safety and efficiency of flights serving Richmond International Airport, Andrews Joint Base Airport and at least nine smaller airports.

Airspace Redesign in Canada

Windsor-Toronto-Montreal

The Windsor-Toronto-Montreal corridor is the busiest air corridor in Canada. Roughly 3 000 flights per day fly through the corridor which covers approximately 140 000 square kilometers.

In February 2012, Phase 1 of Airspace Redesign was put into effect. Changes were made to flights paths at several airports and in the en route airspace east of Toronto, making air operations in the corridor more efficient. These changes reduced cumulative flying time by 10 hours daily and reduced greenhouse gas emissions by 15 000 tonnes annually.

Later phases of the redesign, involving airspace to the north and south of Toronto, are now complete. Changes in these areas required extensive coordination with the Federal Aviation Administration to ensure corresponding adjustments to routes in U.S. airspace.

This airspace redesign will safely improve route segregation between inbound and outbound aircraft, reduce distance for many routes from the north and west, and enable air

traffic controllers to offer pilots more continuous climb opportunities. It is expected that customers will be able to save an additional $6 million per year in fuel costs starting in 2015. Reduced track miles and more efficient climbs will contribute to reduced greenhouse gas emissions of 16 000 metric tonnes. In total, customers will be able to save $50 million and reduce greenhouse gas emissions by 129 000 tonnes until 2020.

WTM Changes made in 2012

Reduced the flying time between Montreal and Toronto by 1.5 minutes

Reducing overall flying time in the corridor by over 10 hours daily

Savings until 2020

$50 Million

129 000 tonnes of CO2e

Edmonton route optimization

In northern Canadian airspace, there remain large areas without air traffic control surveillance. Customers exiting the North Atlantic for destinations in western North America were required to file flight plans on pre-established tracks called the NOR OTS when overflying this area. In December 2013, NAV CANADA stopped publishing the NOR OTS, instead allowing customers to file their User Preferred Routes (UPR).

These new routes reduce flight distances and flight times, resulting in lower greenhouse gas emissions. For some Asian-U.S. routes, customers report reductions of over 25 miles and up to five minutes of flying time. In total, customers will be able to save $51 million and reduce greenhouse gas emissions by 129 000 tonnes until 2020.

Edmonton Changes made in 2013

Reductions of 5 minutes flying time through route optimization

Saving $6 million in fuel in 2013

Savings until 2020

$51 Million

129 000 tonnes of CO2e

Continuous Descent Operations (CDO), Continuous Climb Operations (CCO)

Making the Terminal Area More Efficient

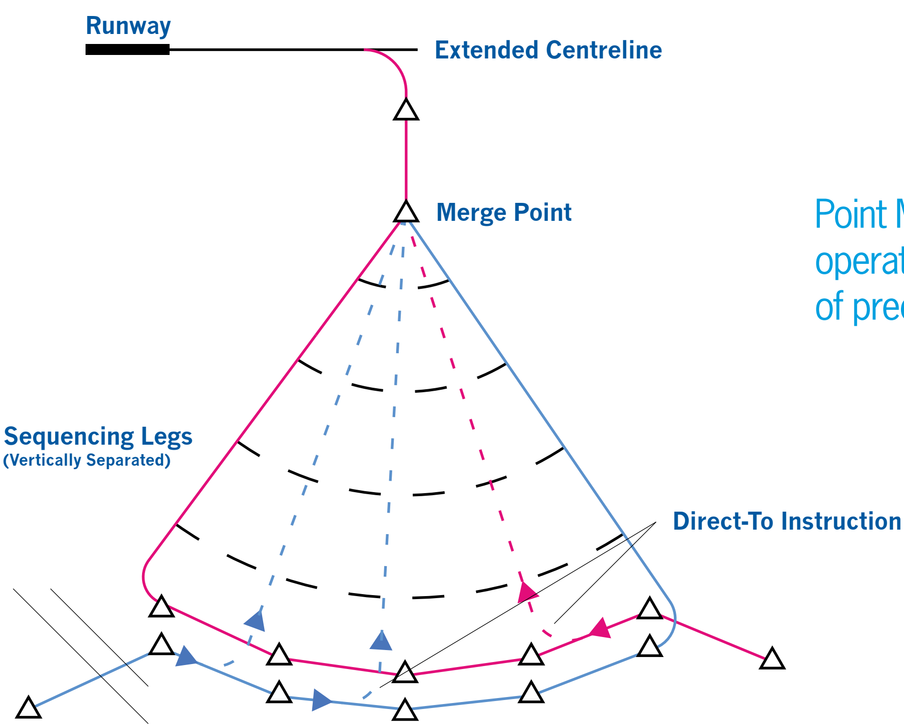
Application of CCO and CDO has led to many operational efficiency benefits in the terminal area. The fact that aircraft can operate without altitude restrictions during departure or arrival phases and thus optimize their flight profile results in less noise exposure and reductions in fuel burn and greenhouse gas emissions. Today, many States have implemented variations of both CDO and CCO.

Point Merge Concepts

The Point Merge system which is a form of CDO, provides both the pilots and air traffic control operators a greater degree of predictability when aircraft approach the airport.

Prior to commencing final approach, all aircraft fly a predetermined arc at an equal distance to landing where the landing sequence is then determined by giving direct-to instructions. This enables aircraft to utilize their onboard flight management systems to facilitate a continuous descent towards the runway, thereby reducing pilot workload in this critical phase. This ensures an efficient and well-organized flow of arriving aircraft compared to traditional vectoring.

With this technique, aircraft follow an RNAV routing, which generally includes a level flight arc segment until receiving a "direct to" routing to a merge point. The pilot may execute a CDO prior to the merge point arc, maintain level flight whilst following the arc and continue with CDO when cleared to the merge point. When traffic levels permit, the aircraft would be cleared direct to the merge point rather than establishing on the arc.



Point Merge systems provide operators a greater degree of predictability on approach

Success Stories

Southern Norway Airspace

In November 2014, Avinor Air Navigation Services implemented the Southern Norway Airspace Project (SNAP) with Point Merge arrival sequencing to improve capacity and flight safety in airspace in the south-western part of Norway. The implementation makes Avinor Air Navigation Services the first in the world to have implemented a second Point Merge project.

SNAP entailed development of new continuous decent operations and continuous climb operations at 16 airports, including Point Merge structures for the larger airports Sola, Flesland and Værnes. It will increase flight safety, ensure increased airspace capacity, and a standardized and efficient service, while reducing CO2 emissions as traffic continues to increase. SNAP also facilitates the implementation of free route airspace in the functional airspace block NEFAB.

Avinor Air Navigation Services was the first ANSP in the world to implement the Point Merge System in 2011. The implementation of Point Merge for Oslo Airport Gardermoen was part of the comprehensive Oslo ASAP project (Advanced Sectorisation and Automation Project), and the point merge arrival route system facilitated an increase in capacity at Oslo Airport Gardermoen.

The arrival route system was originally developed by EUROCONTROL to improve and harmonize arrival operations.

Irish Aviation Authority Dublin Point Merge

Point Merge was successfully introduced by the Irish Aviation Authority (IAA). Point Merge at Dublin will greatly reduce the need to put aircraft into traditional holding patterns, thereby providing environmental benefits by cutting fuel burn and CO2 emissions, as well as reducing delays to passengers.

Before Point Merge:

- No pilot anticipation of distance to go
- Controller workload high
- Less capacity and growth potential (II Rwy)
- Not fuel efficient
- Less continuous descent
- Not using full FMS capability
- Radar vectoring at low altitudes

With Point Merge:

- Full pilot anticipation of distance to go
- Mostly continuous descent (120 Kms)
- Early Direct-to routings
- Total FMS operations
- Optimum profiles
- Further capacity potential

Fuel, Time and CO2 saving for airline customers:

- 127kg of fuel per flight
- 19.1% saving in their fuel requirement per flight
- £78.10 cost saving per flight (based on average jet fuel prices in 2013)
- £4.6m total savings during 2013 and during 2014 (based on current estimates of 60 000 flights per annum that can benefit at Dublin)
- 11.3 nautical miles average track distance per flight saved in Dublin CTA
- 20.3% saving in distance
- 369kg of CO2 emissions (0.4 metric tonnes per flight)
- 19.1% of their CO2 emissions
- 23 500 tonnes of total CO2 saving during 2013 and during 2014

ANSP Benefits:

- More capacity with existing controller resources (including Single Sector configuration): average capacity gains of 30% per sector.
- Improved ATCO situational awareness: aircraft are flying on predictable trajectories making transfer between sectors and sequence building very intuitive.
- Reduce RTF instructions: available cognitive time increased, leading to safety enhancements.
- ATM ground system does not need upgrade: the main difference is addition of mapping.

Recent ICAO Developments

Search and Rescue (SAR)

An effective and globally consistent approach to search and rescue services is essential to a modern Global Air Transport System.

The High-level Safety Conference (HLSC) 2015 concluded that the effectiveness of the current alerting and search and rescue services should be increased by addressing a number of key improvement areas, including the need to determine the position of an aircraft at any time in any location to maintain the confidence of the public in a safe air transport system, and by improving SAR procedures.

The conference also concluded that States should ensure the safety of civil aircraft through civil/military coordination as outlined in the ICAO circular on *Civil/Military Cooperation in Air Traffic Management* (Cir 330).

In a cooperative effort between industry and ICAO, the Global Aviation Distress and Safety System (GADSS) has been developed for the implementation of normal, abnormal and distress flight tracking, search and rescue (SAR) activities and retrieval of cockpit voice recorders (CVRs) and flight data recorders (FDRs) data. A work programme on developing and implementing this concept will continue throughout 2015.

GADSS alone will not address all the deficiencies in the global SAR system and to that end some regions have begun a process of SAR Task Forces to address the deficiencies in SAR preparedness. The process is being led by the Asia/Pacific Region, where a SAR Task Force is in the final stages of developing a Regional SAR Plan to address deficiencies by States. The model being developed by the Asia/Pacific Region is being adopted by other regions in an evolving effort to address SAR preparedness shortfalls.

A further recommendation of the HLSC was that ICAO should support regional SAR training exercises related to abnormal flight behaviour and share the outcomes with the international community. This recommendation has been included in the work programme of the Regional SAR Task Forces, particularly for Asia/Pacific, and with the assistance of Headquarters staff is in the early planning stage. Such exercises are expected to be programmed throughout 2015 and 2016 and will support other elements of the GADSS concept related to global tracking and distress tracking.

MET Divisional Meeting

The world of aeronautical meteorology stands at a crossroads in the evolution of services. Since the beginning of aviation, there has been a need for weather forecast information to support operations, which has been developed in the form of products such as METAR and TAF.

The ICAO Meteorology Divisional Meeting (2014) was held conjointly with the World Meteorological Organization (WMO) in Montréal from 7 to 18 July 2014. This meeting was attended by more than 300 delegates from almost 100 States and seven international organizations. It was recognized by the meeting that with the introduction of system-wide information management (SWIM), the way in which information is provided will need to be fundamentally changed with the integration of data from flight management, aeronautical and meteorological information into a new air traffic management system for the future. This will require a change in mindset for the whole community and a consequent change to the ICAO provisions governing the service delivery requirements.

The first meeting of the newly established Meteorology Panel was held from 20 to 24 April 2015, thus embarking on a complex path to this new environment. This path will require close coordination with other panels working in the air traffic management, information management, communications and flight operations domains as well as a continuation of the longstanding relationship with WMO.

Procedures for Air Navigation Services — Aerodromes (PANS-Aerodromes, Doc 9981)

The first edition of the *Procedures for Air Navigation Services – Aerodromes* (PANS-Aerodromes, Doc 9981) has recently been approved by the President of the Council, on behalf of the Council, with an applicability date of 10 November 2016.

The PANS-Aerodromes specify, in greater detail than the SARPs in Annex 14 — *Aerodromes*, Volume I — *Aerodrome Design and Operations*, operational procedures to be applied by both aerodrome regulators and operators to ensure aerodrome operational safety and to improve overall system capacity and efficiency, in particular at congested aerodromes.

This first edition of the PANS-Aerodromes addresses priority areas revealed by the Universal Safety Oversight

Audit Programme (USOAP) audits in the areas of aerodrome certification, conduct of safety assessments and compatibility studies.

ICAO is currently working on the second edition of the PANS-Aerodromes, which will cover operational procedures for airside inspections, work in progress on the airside, FOD, and wildlife management, etc. It is envisaged that the second edition of the PANS-Aerodromes will be published in 2018.

Aviation Frequency Spectrum

The safety of air operation is dependent on the availability of reliable communication and navigation services. Current and future communication, navigation and surveillance/air traffic management (CNS/ATM) provisions are highly dependent upon sufficient availability of radio frequency spectrum that can support the high integrity and availability requirements associated with aeronautical safety systems, and demand special conditions to avoid harmful interference to these systems. Spectrum requirements for current and future aeronautical CNS systems are specified in the ICAO Spectrum Strategy.

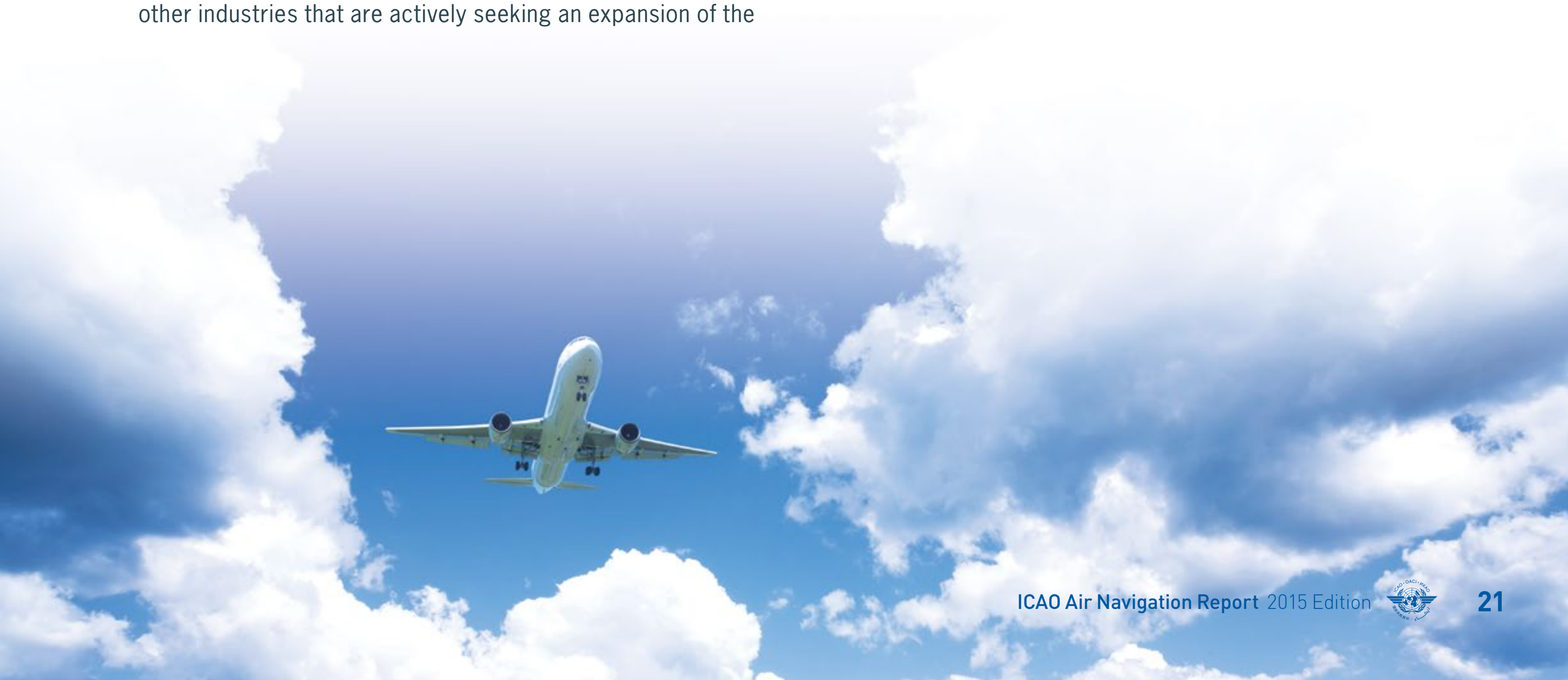
International provisions for radio frequency spectrum management, set down in the International Telecommunication Union (ITU) Radio Regulations, are updated during World Radiocommunication Conferences (WRCs) held by the ITU every four years, the next of which will be held in November 2015 (WRC-15).

At WRC-15, aviation will have to compete with a number of other industries that are actively seeking an expansion of the spectrum available to them, resulting in an ever-increasing pressure on existing allocations for safety and regularity of flight, and danger of interference to the aeronautical services using those allocations.

Preparatory activities towards WRC-15 (2015) are well under way. In line with the results of on-going studies within the ITU Radiocommunication Sector, updates to the ICAO Position for WRC-15, as approved by Council in 2013 (ICAO State letter E 3/5.15-13/57), will be developed and disseminated to States in time for the conference.

In line with the recommendations of the High-level Safety Conference (HLSC) 2015, the updated ICAO Position for WRC-15 will include proposals for solution of a new item, "Global Flight Tracking for Civil Aviation", as specified in Resolution 185 of the ITU Plenipotentiary Conference (PP-14, October 2014).

Other issues of major interest to aviation to be addressed at WRC-15 include: (WRC-15 agenda item 1.1) potential reallocation of certain aeronautical frequency bands for broadband and mobile services; (WRC-15 agenda item 1.5) potential use of fixed satellite service (FSS) spectrum (non-safety) for command and control of remotely piloted aircraft; (WRC-15 agenda item 1.17) wireless avionics intra-communications (point-to-point radio links on aircraft to replace wiring for certain safety critical applications); (WRC-15 agenda item 9.1.5) consideration of technical and regulatory actions to protect very small aperture transmission (VSAT) satellite networks used for the transmission of aeronautical and meteorological information in Africa.



Alignment of SUPPs and ANPs

The Twelfth Air Navigation Conference (AN-Conf/12), Recommendation 6/11 “Alignment of air navigation plans and regional supplementary procedures” requested to align the areas of applicability of the air navigation plans and the regional supplementary procedures observing the principles described in the recommendation. The objective was to integrate within each of the PIRGs the responsibilities for development and upkeep of the air navigation plans (ANPs) and the *Regional Supplementary Procedures* (SUPPs) (Doc 7030) for their respective air navigation regions. The proposed alignment of the areas of applicability of ANPs and SUPPs is expected to simplify the procedures for regional performance framework management for PIRGs and will also support more efficient planning and implementation of the aviation system block upgrades (ASBUs).

The benefits of the alignment of the areas of applicability of the ANPs and the SUPPs are: a) an immediate and collaborative approach to regional performance framework management which will also support the aviation system block upgrade (ASBU) methodology as only one PIRG will develop and be responsible for upkeep of both the ANPs and the SUPPs for a given airspace; and b) in association with the transition to the electronic air navigation plans (eANP), user-friendly, robust, and simplified planning and editing tools for PIRGs and the ICAO Secretariat to ensure centralization and currency of data.

The process to align the areas of applicability of ANPs and SUPPs has been done in two separate phases, starting first in 2013 with the alignment of the areas of applicability of ANPs (BASIC and FASID) in coordination with affected Regional Offices. The second phase was initiated in 2014 and consisted in the revision of the *Regional Supplementary Procedures* (Doc 7030), aligning the areas of applicability of the regional SUPPs with the areas of the ANPs and amending the SUPPs procedures accordingly. This phase is in progress and is expected to be finalized by end of 2015.

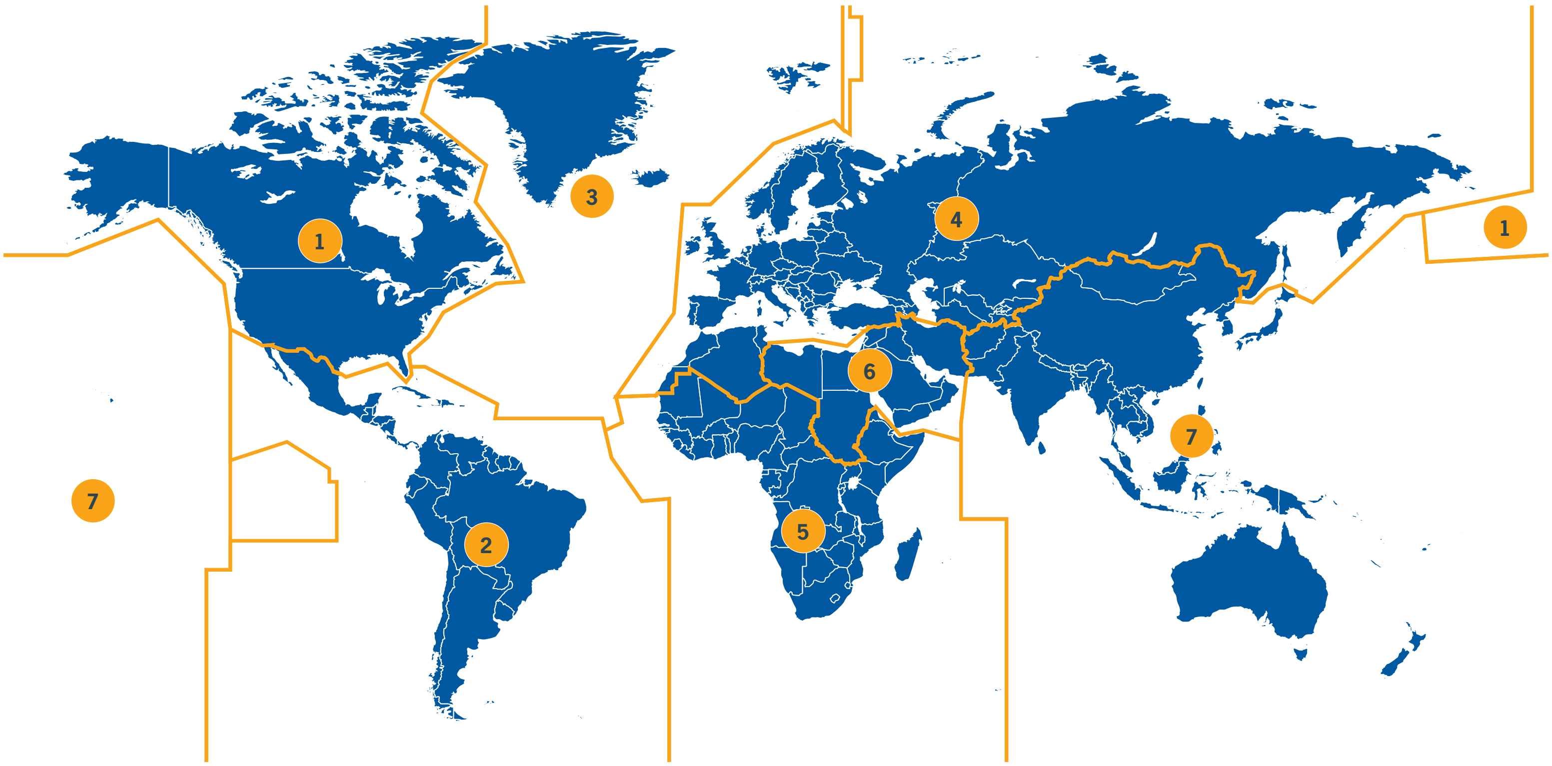
All rules and procedures, including approval by the Council of amendments, which currently apply to the development and upkeep of the ANPs and the SUPPs will continue without changes. To take maximum advantage of the alignment, ICAO will continue to simplify the workflows related to the amendment processes associated with the data in the ANPs and the SUPPs in order to increase efficiency, accuracy, and accessibility.

The main changes in SUPPs areas of applicability are the demerge of MID/ASIA regions, the combining of ASIA with PAC regions and the merging of CAR and SAM regions. Some changes were made in the areas of applicability of the ANPs in the AFI, ASIA and MID regions with the movement of some FIRs between ANPs.

Next Generation of Aviation Professionals (NGAP)

During the Second NGAP Symposium, Zurich University of Applied Sciences (ZHAW) presented a prototype of an NGAP Index. Its purpose is to provide States with a tool to better understand aviation human resource needs within their States and develop strategic plans to ensure the right number of competent personnel are available to support the aviation system at a national and regional level. Work on an operational tool will be completed by the end of 2015 and made available on iSTARS.

Figure 7: Proposed Aligned Areas of Applicability of ANPs and SUPPs, Responsible PIRGS and Regional Offices Providing Assistance



1 NAM ANP & SUPPs
Canada/US
NACC Office

2 CAR/SAM ANP & SUPPs
GREPECAS
NACC & SAM Offices

3 NAT ANP & SUPPs
NAT SPG
EUR/NAT Office

4 EUR ANP & SUPPs
EANPG
EUR/NAT Office

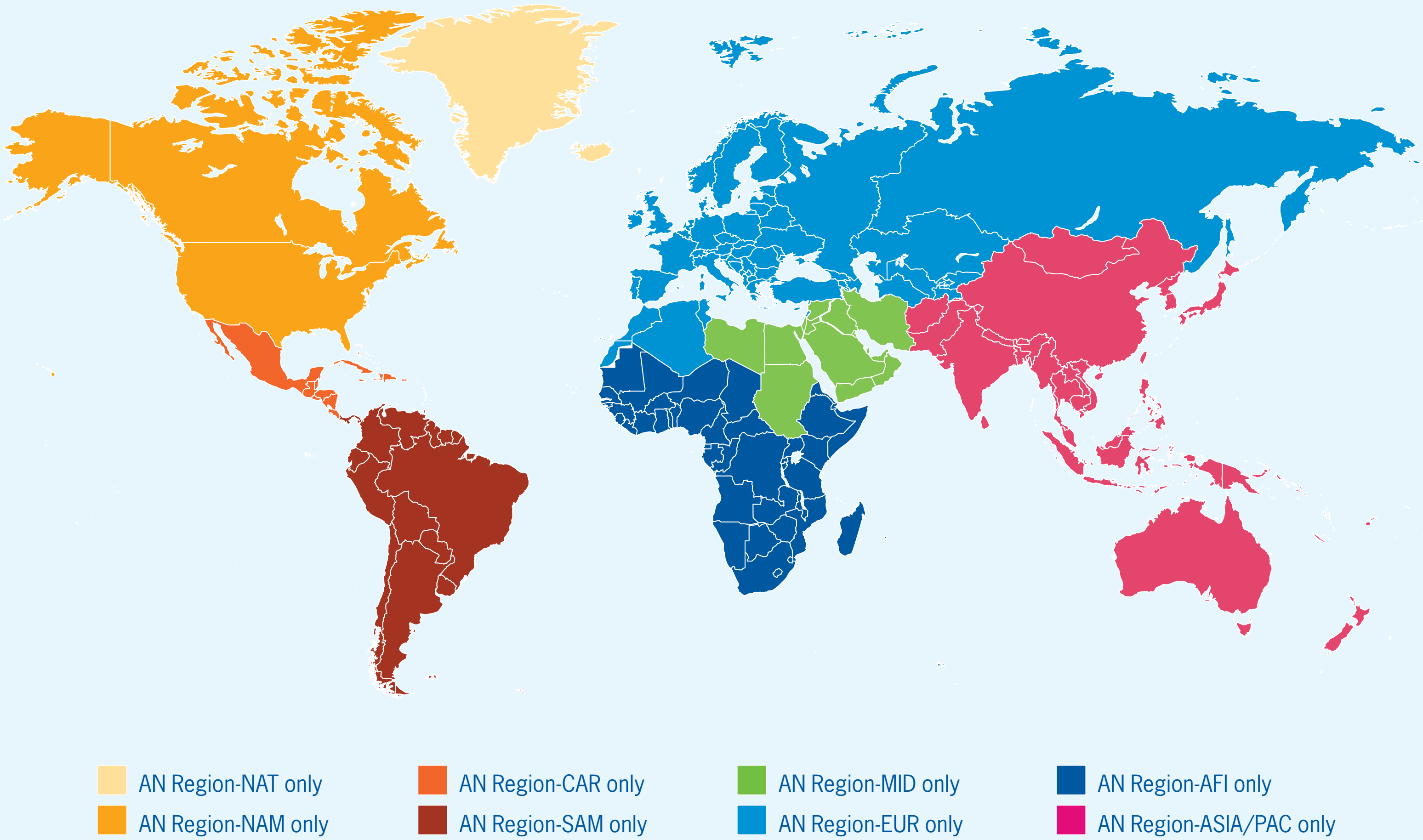
5 AFI ANP & SUPPs
APIRG
ESAF & WACAF Offices

6 MID ANP & SUPPs
MIDANPIRG

7 ASIA/PAC ANP & SUPPs
APANPIRG
APAC Office

Appendix 1 – Air Navigation Regions

For air navigation purposes, ICAO Member States are grouped by air navigation region. The region to which each State belongs is listed below. Some States may however have flight information regions in multiple regions.



African (AFI) Region (48 States)

Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Swaziland, Togo, Uganda, Zambia, Zimbabwe, South Sudan, United Republic of Tanzania, Democratic Republic of the Congo, Cote d'Ivoire, Congo

Asia-Pacific (ASIA/PAC) Region (39 States)

Afghanistan, Bangladesh, Bhutan, Brunei Darussalam, Cambodia, China, Democratic People's Republic of Korea, India, Indonesia, Japan, Lao People's Democratic Republic, Malaysia, Maldives, Mongolia, Myanmar, Nepal, Pakistan, Philippines, Republic of Korea, Singapore, Sri Lanka, Thailand, Timor-Leste, Viet Nam, Australia, Cook Islands, Fiji, Kiribati, Marshall Islands, Micronesia (Federated States of), Nauru, New Zealand, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu

Caribbean (CAR) Region (20 States)

Antigua and Barbuda, Bahamas, Barbados, Costa Rica, Cuba, Belize, Dominica, Dominican Republic, El Salvador, Grenada, Guatemala, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Trinidad and Tobago

European (EUR) Region (57 States)

Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkey, Turkmenistan, Uzbekistan, Cyprus, Israel, Belarus, Belgium, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Ukraine, Russian Federation, United Kingdom of Great Britain and Northern Ireland, Albania, Andorra, Austria, Bosnia and Herzegovina, Bulgaria, Holy See, Hungary, Ireland, Malta, Monaco, Montenegro, Poland, Republic of Moldova, Romania, San Marino, Serbia, Slovakia, Slovenia, Liechtenstein, The former Yugoslav Republic of Macedonia, Algeria, Morocco, Tunisia

Middle-East (MID) Region (15 States)

Bahrain, Iraq, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, United Arab Emirates, Yemen, Iran (Islamic Republic of), Egypt, Libya, Sudan

North-American (NAM) Region (2 States)

Canada, United States of America

North-Atlantic (NAT) Region (1 State)

Iceland

South-American (SAM) Region (13 States)

Argentina, Brazil, Chile, Colombia, Ecuador, Guyana, Panama, Paraguay, Peru, Suriname, Uruguay, Venezuela (Bolivarian Republic of), Bolivia (Plurinational State of)

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