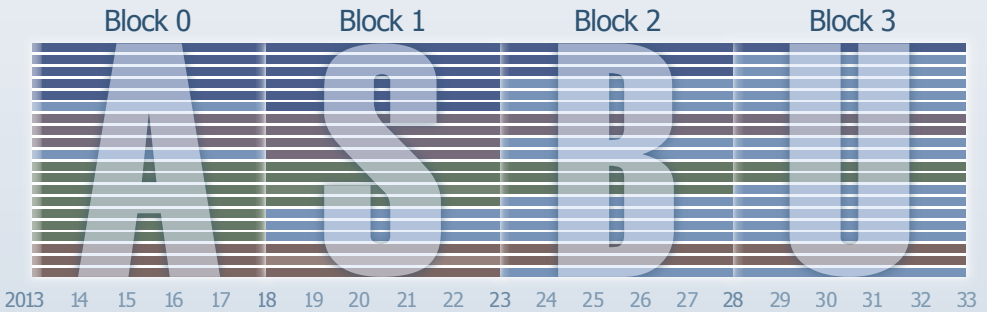


Introduction to the Aviation System Block Upgrade (ASBU) Modules

Strategic Planning for ASBU Modules Implementation



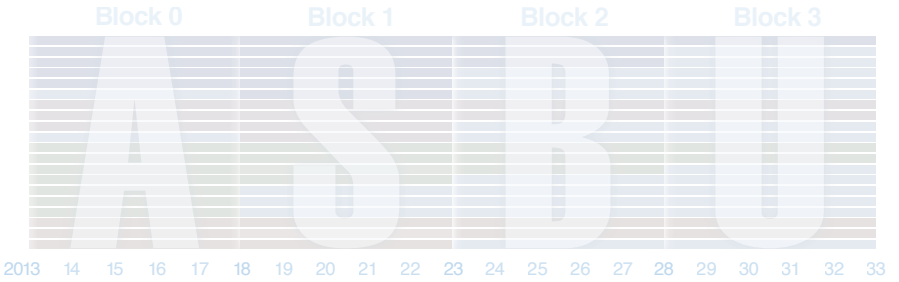


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Foreword

CANSO is providing this ASBU 101 introduction booklet to help facilitate strategic planning initiatives in air traffic management (ATM). This booklet introduces the ASBU framework and the required integrated implementation processes of business case and needs and dependency analysis (NDA). These processes must be performed in order to select and implement the ASBU modules that best meet the operational needs of individual air navigation service providers.

The booklet is also intended to help readers acquire an understanding of the global harmonisation vision, goals and challenges.

1. Executive Summary

The International Civil Aviation Organization’s (ICAO) Global Air Navigation Plan (GANP) presents a framework for harmonising avionics capabilities and the required air traffic management (ATM) ground infrastructure as well as automation. The framework is the Aviation System Block Upgrades (ASBUs). An ASBU is a package of capabilities (modules) which has essential qualities of:

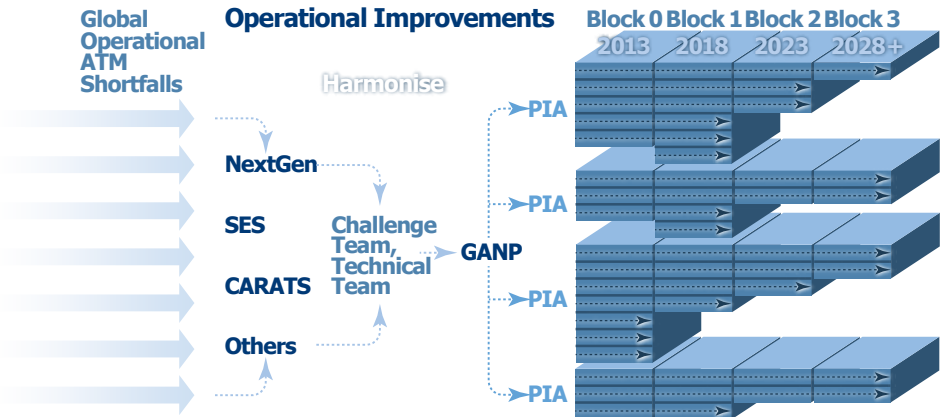
- Clearly defined measurable operational improvements with appropriate metrics to determine success
- Necessary equipment and/or systems in aircraft and on the ground along with an operational approved or certification plan
- Standards and procedures for airborne and ground systems
- Positive business case over a clearly defined period of time

The ASBUs provide a roadmap to assist air navigation service providers in the development of their individual strategic plans and investment decisions with a goal of global aviation system interoperability.

This booklet provides an overview of the processes that will guide decision makers’ selection and implementation of the ASBUs to ensure global interoperability and to meet their individual regional requirements. These processes include the business development case and a needs and dependency analysis (NDA). These processes and their key elements are presented to illustrate a structured approach for ASBU implementation.

The ASBUs are programmatic and flexible, which allows air navigation service providers to advance their air navigation system based on their individual

Meeting the Needs of Aviation Service Providers



operational requirements. Future CNS/ ATM system upgrades, as described in the ASBU framework, will be evolutionary, and must be based on a well-understood, manageable, and cost effective sequence of improvements. These improvements must keep pace with the needs of ANSPs and culminate in a globally interoperable system. The ASBUs will enable future aviation systems worldwide to efficiently manage traffic demand and enhance safety, capacity, predictability, security, effectiveness, and environmental stewardship.

This CANSO ASBU 101 book provides an understanding of global aviation system harmonisation vision, goals and challenges. The ASBU objectives, capability threads and minimum path to achieve global interoperability are presented.

2. Introduction

This CANSO ASBU booklet is intended for ANSPs, airports, operators, military aviation and industry to understand the requirements for enhancing aviation systems and services through the implementation of the ASBUs.

The ASBU modules contained in Block 0 and Block 1 are elaborated

to help the reader acquire a clear understanding of the need to upgrade the existing systems in a timely manner. Due to the date of availability, 2023 and 2028 respectively, the ASBU modules contained in Blocks 2 and 3 are not discussed beyond the introduction of the module thread concept across Blocks.



The ASBU modules in Blocks 2 and 3 must:

1. Be economically feasible
2. In certain airspace, support the operating environment in 2023 and 2028 respectively
3. Block 3 must represent an end-state as envisioned in the ICAO Global ATM Operational Concept.²

This booklet is designed to help readers acquire an understanding of the ASBU concept and its vision of global aviation system harmonisation, goals and challenges. Also contained in this book is a discussion of ICAO's proposed Minimum Path selection rationalisation and concept (the criteria for module prioritisation) to achieve global interoperability.

Addressed in this book are the selection and implementation processes of business case and needs and dependency analysis (NDA). The impacts of environmental and societal elements are also presented. Although the ASBUs are built on a global harmonisation perspective, not all ASBU capabilities will be developed and implemented uniformly, or at the same time around the world. This booklet presents the introduction to an NDA that may be used by each decision maker to help the process of selecting ASBU capabilities that satisfy their

individual operational requirements and to help develop their strategic implementation plans. The ASBUs are evolutionary and are based on a well-understood, manageable, and cost-effective sequence of improvements that keep pace with ANSPs' and operators' needs. These improvements culminate in a system that meets the demands for safety, capacity, efficiency, predictability, security, effectiveness, and environmental stewardship. The future ATM system must transform the existing systems for a broad community of ANSPs into seamless worldwide operations and support progressive levels of avionics equipage.

3. Global Harmonisation Vision and Goals

Goals

Cooperation Coordinate Collaborate

Harmonisation Standards
Technology Procedures
Timeline/Deployment

Interoperability
Air
Ground

A global ATM system is envisioned as the foundation of a worldwide integrated, harmonised and interoperable air transportation system. Such a system is intended to integrate regional and local ATM systems to interoperate and provide seamless services across all regions, sub-regions and States. The system will provide services to all users in all phases of flight.

This globally interoperable system will meet requirements for safety and security and provide optimum economic operations that are environmentally sustainable and cost effective.

The ICAO vision of global harmonisation is based on the need for:



- Uniform level of safety across all regions, sub-regions and States
- Optimised traffic flows across all regions, sub-regions and States
- Physical system-to-system connectedness, sharing pertinent data across systems and regions
- Common performance requirements, standards and operating procedures
- Common aeronautical information exchange
- Meeting environmental objectives
- Meeting minimum and common security objectives

The goals of the ASBUs are to provide a framework and road map for cooperation, harmonisation and interoperability in the development of a global ATM system, between air navigation service providers and States. This ATM system will meet local operational needs and objectives, and is interoperable with adjacent regions, sub-regions and States; and adheres to international standards.



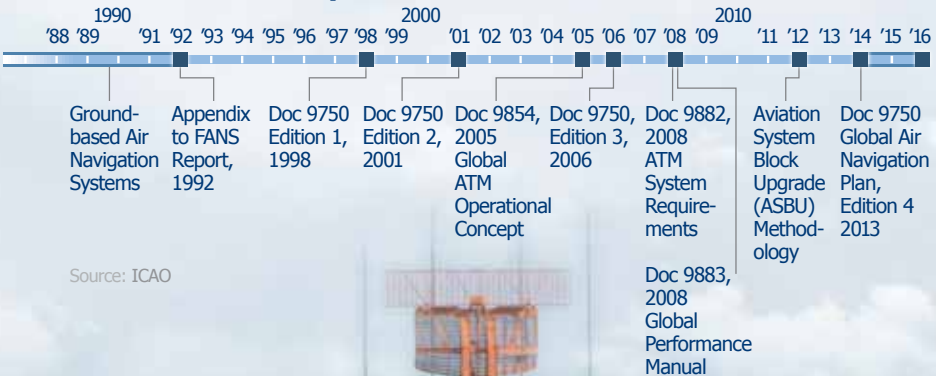
4. The ASBU Background

Civil aviation systems and supporting infrastructure are transitioning from a ground-based CNS air traffic control (ATC) system to a satellite-based CNS/ATM system. ICAO authored the Global Coordinated Plan, published in 1998, to guide the upgrade of air/ground system technologies through the implementation of CNS/ATM system enhancements. This plan was revised into the first Global Air Navigation Plan (GANP) for CNS/ATM Systems (Doc 9750) with the intention of making it a 'living document'. The GANP includes planning elements for technical, operational, economic, environmental, financial, legal and institutional aspects. The GANP provided the impetus to a number of ICAO member States and regions to initiate implementation programmes to improve operations through the use of enhanced technologies. Since the implementation of interoperable technologies was necessary, it

was not achievable without a comprehensive operations concept of an integrated global air navigation system.

The ICAO Air Navigation Commission (ANC) established the ATM Operational Concept Panel (ATMCP) to develop a Global ATM Operational Concept (Doc 9854) that was endorsed by the 11th Air Navigation Conference in 2003. The concept was approved by the Secretary General and published as a first edition (Doc 9854/AN/458) in 2005. In order to guide the aviation community in transitioning from an ATC operating environment to a performance-based integrated and collaborative ATM environment, the GANP was developed, incorporating global operational concepts and ICAO's strategic objectives. There have been multiple revisions of the GANP, the latest edition being

Evolution of ATC Systems



Source: ICAO



Source: MITRE

2013-2028 Global Air Navigation Plan (ICAO Doc 9750-AN/963, Fourth Edition–2013). This edition presents all States with a comprehensive planning tool to upgrade their existing systems to support global harmonised air navigation. The GANP presents the ASBU framework and identifies the next generation of ground and aviation technologies needed to achieve the desired performance improvements from the ASBU modules. The ASBU framework is intended to provide guidance to the States, service providers and operators in making decisions for planning and implementing their aviation system upgrades.

5. The ASBUs

The ASBU framework is ICAO's systems engineering approach to achieve global ATM interoperability and harmonisation. The Block Upgrades are the product of inclusive and prolonged collaboration between ICAO, ANSPs, member States and industry stakeholders from around the world.

A number of air navigation improvement programmes undertaken by ICAO member States – namely SES, NextGen, CARATS, SIRIUS, and others in Canada, China, India, and the Russian Federation –

are planned to be implemented with the ASBU framework.

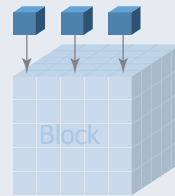
The Block Upgrades present target implementation time frames for sets of operational improvements, referred to as modules. A single module defines a single capability (operational improvement) and its required technologies and procedures. Each Block Upgrade has been organised into a set of unique modules that are linked to one of four aviation performance improvement areas (PIAs).

Air Traffic Management Modernisation Programmes



Harmonisation gains
The GANP presents a vision that will assist ICAO, States, and air navigation service providers ensure global interoperability and harmonisation.

ASBU Modules
Each of the ASBU Blocks is composed of Modules (capabilities).



Source: ICAO

- Airport Operations
- Globally Interoperable Systems and Data
- Optimum Capacity and Flexible Flights
- Efficient Flight Paths

The Block Upgrades (0, 1, 2 and 3) represent a twenty+ year planning and implementation time frame as defined by the GANP. The PIAs and their modules are organised into a series of four, one for each PIA (Blocks 0, 1, 2, and 3) assigned to an implementation time frame.

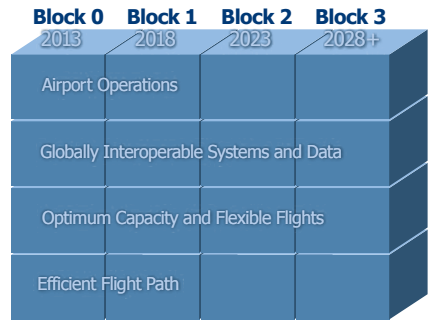
The ASBUs make it possible for air navigation service providers to form their independent implementation and investment strategy by selecting and implementing only those modules appropriate for their individual operational needs.

The development of a business case is necessary to determine module cost benefit. The business case is discussed later in this booklet.

The required technologies for Block 0 exist, and the associated operational capabilities of Block 0 have been implemented in some ICAO Regions. The Block 0 modules have initial operational capabilities (IOC) of 2013.

They are therefore available for ANSPs' and operators' implementation. The modules assigned to Block 1 through Block 3 represent emerging operational improvements with IOCs for 2018, 2023 and 2028 respectively. The typical navigation planning approach normally addresses only the concerns of ANSPs. However, the ASBU methodology addresses standards, regulatory and user requirements as well.

Performance Improvement Areas (PIAs)

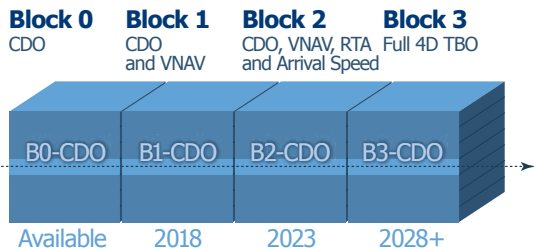


The IOCs of the Block Upgrade modules are not Block timeframe deadlines. Individual ANSPs and operators may implement Block Upgrade modules at any time after they become available, as long as the organisation deems them as an operational requirement.

The individual ASBU module contains a number of elements that define the CNS and ATM automation upgrade components of ground, air and decision support tools needed for the module implementation. This approach ensures that each module can be used as guidance for selecting requirements for a deployable performance improvement capability.

Threads of Modules Across Blocks

A series of upwardly compatible, although dependent, modules across consecutive blocks is considered as a "thread" representing the evolution over time for advancing module performance. Modules are identified by a Block Number with an ASBU identifier.

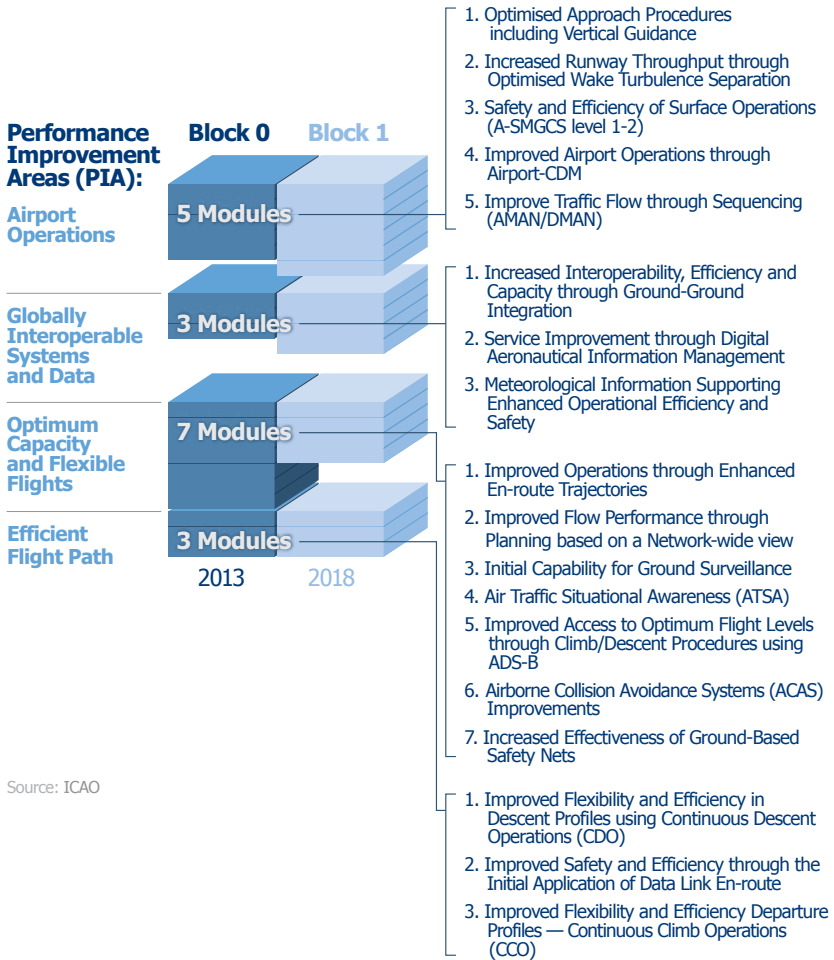


ASBU Block 0 Modules

The number of modules may not be equal for each PIA in each succeeding Block Upgrade.

Some modules may be completely implemented in a specific Block time frame and require no further upgrade.

However, some modules and their capabilities in a PIA improve over time as they evolve through succeeding Block Upgrades. Block 0, represented below, consists of 18 modules, while Block 1, represented on the following page, has only 17 modules.



Source: ICAO

ASBU Block 1 Modules

Block 1 contains 15 modules that are continued in thread from Block 0. Three new modules are introduced in Block 1 and three modules from Block 0 that may be completely implemented in the Block 0 timeframe are not upgraded in Block 1 and are therefore not continued as a thread.

Essential modules are introduced in Block 1 and they are presented in the graphic below. ICAO has defined

■ = Essential Modules

Performance Improvement Areas (PIAs):

Airport Operations

Globally Interoperable Systems and Data

Optimum Capacity and Flexible Flights

Efficient Flight Path



Source: ICAO

these modules as essential as they provide substantial contributions towards global interoperability, safety or regularity of flight. These modules are also considered as

providing a prerequisite step towards the aviation system performance objectives of the GANP. The ASBU Minimum Path (Essential, Desirable, Specific and Optional modules) is presented on the following pages.

1. Optimised Airport Accessibility
 2. Increased Runway Throughput through Optimised Wake Turbulence Separation
 3. Enhanced Safety and Efficiency of Surface Operations — Surf, Surf-1A, and Enhanced Vision Systems (EVS)
 4. Optimised Airport Operations through A-CDM Total Airport Management
 5. Remotely Operated Aerodrome Control
 6. Improved Airport Operations through Departure, Surface and Arrival Management
-
1. Increased Interoperability, Efficiency and Capacity through FF-ICE/1 application before Departure
 2. Service Improvement through Integration of all Digital ATM Information
 3. Performance Improvement through the Application of SWIM
 4. Enhanced Operational Decisions through Integrated Meteorological Information (Planning and Near-term Service)
-
1. Increased Capacity and Efficiency through Interval Management
 2. Improved Operations through Optimised ATS Routing
 3. Improved Flow Performance through Network Operation Planning
 4. Ground-based Safety Nets on Approach
-
1. Improved Flexibility and Efficiency in Descent Profiles (CDOs) using VNAV
 2. Initial Integration of Remotely Piloted Aircraft (RPA) into Non-integrated Airspace
 3. Improved Traffic Synchronisation and Initial Trajectory-Based Operation

ASBU Minimum Path to Global Interoperability, Module Categorisation and Prioritisation

To promote the rationalisation and prioritisation of the ASBU modules, a set of categories are proposed (a current ICAO proposal) for consideration by States within the respective PIRGs (ANConf/12-WP/25-Appendix A).

Some modules must be implemented globally and are therefore designated as forming a required part of the minimum path to global interoperability. Deployment of such modules in the earliest available timeframe will result in maximum aviation system benefits and the implementation of any such modules should take place within the same approximate time periods. It is also expected that the modules other than those agreed to be essential at a global level, may be categorised differently between regions.

The *proposed* categories are:

- a. **Essential (E):** These are the ASBU modules that provide substantial contribution towards global interoperability, safety or regularity of flight, and in many cases a prerequisite step towards the GANP's aviation system performance objectives.
- b. **Desirable (D):** These are the ASBU modules that are recommended for implementation almost everywhere because of their strong business and/or safety case.
- c. **Specific (S):** These are the ASBU modules that are recommended for implementation to address

a particular operational environment or mitigate identified risks.

- d. **Optional (O):** These are the ASBU modules that address particular operational requirements and provide additional benefits that may not be common everywhere.

The 17 Block 1 modules are categorised as follows:

Essential:

- Optimised Airport Accessibility
- Increased Interoperability, Efficiency and Capacity through Flight and Flow Information for the Collaborative Environment (FF-ICE/1) application before Departure
- Service Improvement through Integration of all Digital ATM Information
- Performance Improvement through the application of System Wide Information Management (SWIM)
- Increased Capacity and Flexibility through Interval Management
- Improved Flexibility and Efficiency in Descent Profiles (CDOs) using VNAV
- Initial Integration of Remotely Piloted Aircraft (RPA) Systems into non-integrated airspace

Desirable:

- Optimised Airport Operations through Airport-CDM
- Enhanced Operational Decisions through Integrated and Timely Meteorological Information
- Improved Flow Performance

- through Network Operational Planning
- Ground-based Safety Nets on Approach
- Improved Traffic Synchronisation and Initial Trajectory-Based Operations

Optional:

- Increased Runway Throughput through Dynamic Wake Turbulence Separation
- Improved Airport Operations through Departure, Surface and Arrival Management
- Enhanced Safety and Efficiency of Surface Operations
- Remote Operated Aerodrome Control Tower
- Improved operations through optimised ATS Routing

Having a globally prioritised approach will allow for the possibility of better coordination at the State, region and local levels.

It is suggested that air navigation service providers conduct a gap analysis of their current capabilities with the modules presented in Block 0. Implementation of the Block 0 modules is a first step towards developing a globally harmonised system as early as possible and enhances the implementation of the Essential modules contained in Block 1.

Block 0 module testing and development has been completed and all modules are currently available for implementation. Each of the Block 0 modules have the necessary standards readiness, avionics/ ground systems/ procedures

availability, and operational approvals. However, not all ANSPs will need to implement all modules. Each ANSP must perform a needs and dependency analysis (NDA) to decide which modules are candidates to meet their organisational objectives.

In order to meet the global goal of interoperability and harmonisation, ANSPs are encouraged to consider not only their individual operational needs but also to consider their regional plans as detailed within their PIRG.

ICAO has proposed a Minimum Path methodology for Block 1 modules. This methodology classifies Block 1 modules into categories of priority. There are 7 Block 1 modules that ICAO considers as Essential for air navigation service providers to adopt and implement in order to achieve a global interoperable system. The Essential Block 1 modules may have thread predecessors in Block 0, thus making the predecessor Block 0 modules' implementation essential as air navigation service providers build a foundation that will become an integral part of the global air transportation system. For example, Optimised Approach Procedures including Vertical Guidance in Block 0 is needed for Optimised Airport Accessibility in Block 1.

Rationalising the Block modules into categories or priority will assist all stakeholders' understanding of how the ASBU modules relate to the global system.

Air/Ground Technologies for Block Upgrades 0 and 1 Modules

The ICAO Global Air Navigation Capacity and Efficiency Plan classifies CNS, information management (IM) and avionics technologies as follows:

- a. **Communication:**
air/ground data link communication using VHF Digital Link (VDL)
- b. **Navigation:**
performance-based navigation (PBN)
- c. **Surveillance:**
automatic dependent surveillance-broadcast (ADS-B)
- d. **Information management:**
system wide information management (SWIM)
- e. **Avionics:**
Onboard systems supporting digital communication, PBN and airborne surveillance

In order to foster implementation of Block 1 Modules to provide seamless operations, the global CNS/ATM system will rely on digital

technologies including satellite-based CNS with enhanced automation and information management systems. These upgrades will enable aircraft equipped with compatible CNS avionics to safely meet their planned times of departure and arrivals, while adhering to their optimum flight paths from gate to gate with minimum disruptions. This would require voice and data communications, area navigation (RNAV) and required navigation performance (RNP) capabilities for PBN, ADS-B backed-up with secondary surveillance radars for aircraft surveillance and tracking. The corresponding ground infrastructure upgrades will need to provide data link communication, Satellite-Based Augmentation System (SBAS) for accurate en route navigation, Ground Based Augmentation System (GBAS) for precise approaches in all weather conditions and SWIM for exchange of information between ground systems.



Communication

In the Block 0 timeframe, aviation will rely primarily on existing communication systems such as the Very High Frequency (VHF) Aircraft Communications Addressing and Reporting System (ACARS). The VHF ACARS will be transitioned to VHF Digital Link (VDL)- Mode 2 providing higher bandwidth, since VHF channels have become limited in several regions of the world. In

the Block 1 timeframe, VHF ACARS will be phased-out giving way to VDL-Mode 2, which has been defined and standardised by ICAO to provide more capacity and faster speed (31.5 kbps). Another data link system that has also been defined and standardized through the ICAO is VDL – Mode 4, which can also provide surveillance functions.

Data Communication Technologies

VDL Mode - 2

The VHF Digital Link is a means of sending data information between the aircraft and the ground stations. The VDL Mode 2 is the widely accepted version of VDL. Examples of the type of messages that it can transmit include pre-departure clearance, digital automated terminal information service (D-ATIS), Terminal Weather Information for Pilots (TWIP), or taxi clearances. VDL Mode 2 has been implemented in a Eurocontrol Link 2000+ programme and is specified as the primary link in the European Union (EU) Single European Sky rule adopted in January 2009. This requires all new aircraft flying in Europe after January 1, 2014 to be equipped with Controller Pilot Data Link Communications (CPDLC). In advance of CPDLC implementation, VDL Mode 2 has already been implemented in approximately 2,000 aircraft to transport ACARS messages, simplifying the addition of CPDLC.

VDL Mode - 4

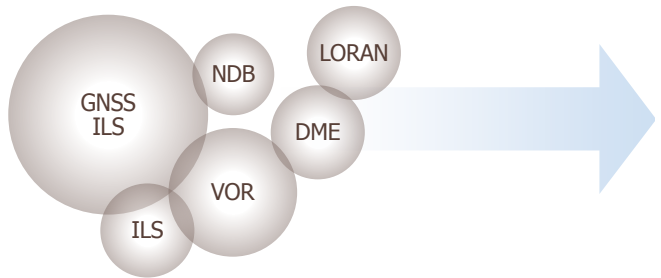
The standard for VDL Mode - 4 specifies a protocol enabling aircraft to exchange data with ground stations and aircraft. VDL Mode - 4 uses a Self-organised Time Division Multiple Access (STDMA) protocol that allows it to be self-organising, meaning that no master ground station is required. In November 2001, this protocol was adopted by ICAO as a global standard. Its primary function was to provide a VHF frequency physical layer for ADS-B transmissions. However VDL Mode 4 was overtaken as the link for ADS-B by the Mode S radar link operating in the 1090 MHz band, which was selected as the primary link by the ICAO ANC in 2003. The VDL Mode 4 medium can also be used for air-ground exchanges. It is best used for short message transmissions between a large number of users, e.g. providing situational awareness.

Transition to Performance Based Navigation (PBN)

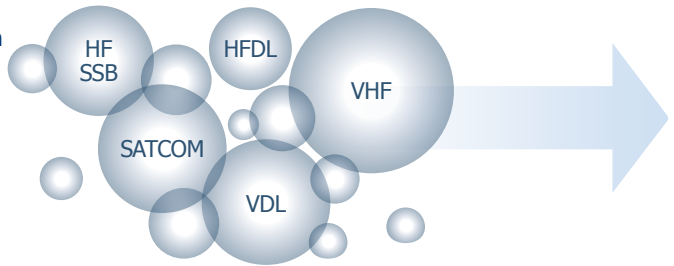
Today

- Disjointed CNS technologies and operational limitations
- Regional solutions
- Many standards
- Regional service variations

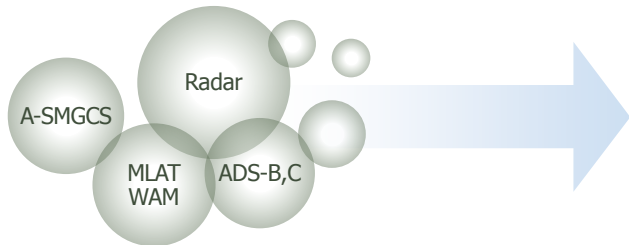
Existing Navigation Systems



Existing Communication Systems

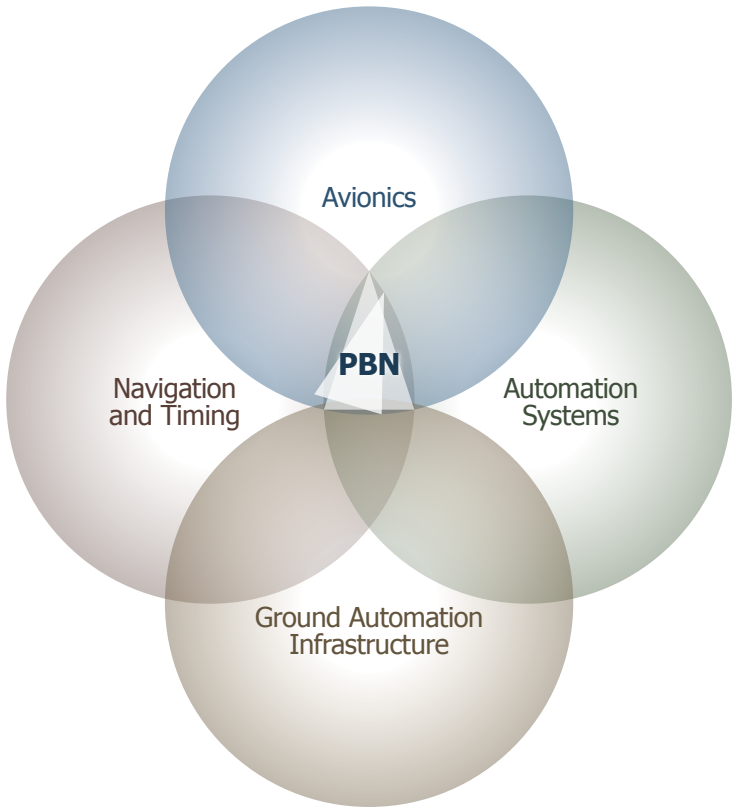


Existing Surveillance Systems



Performance Based Navigation for seamless operations

- CNS Integration
- Global Utility
- Global Performance Standards
- Uniform Levels of Services



Navigation

PBN

The Global Navigation Satellite System (GNSS) is the core technology that has led to the development of PBN. In the Block 0 time frame, the implementation of the PBN concept will make RNAV operations the norm. The existing Distance Measuring Equipment (DME) systems are the most appropriate conventional navigation aids to support RNAV operations as they are used in multi-sensor avionics. The ICAO GANP has the objective of a future harmonised global navigation capability based on RNAV and PBN, supported mainly by GNSS in the Block 1 time period. The ICAO PBN manual and the associated design criteria provide the necessary baseline to commence evolution to a homogeneous navigation environment. The PBN manual includes a number of navigation applications; one of the

key ones is the RNP application.

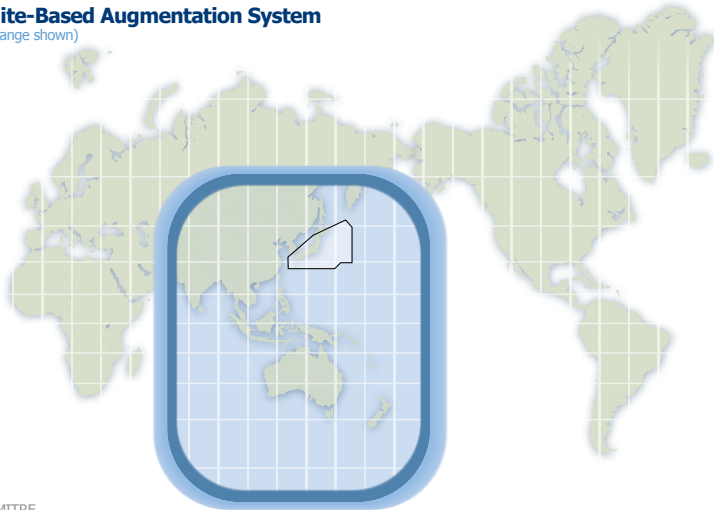
These applications within airspace contribute to the redistribution of the surveillance and conformance monitoring function by providing an integrity check on the aircraft position and allowing automatic detection of non-conformance with the desired flight path. The following are the GNSS supported systems.

Satellite-Based Augmentation System

A satellite-based augmentation system (SBAS) is a system that supports wide-area or regional augmentation through the use of additional satellite-broadcast messages. Such systems are commonly composed of multiple ground stations, located at accurately-surveyed points. The ground stations take measurements of one or more of the GNSS satellites, the satellite signals, or other environmental factors which may impact the signal

Satellite-Based Augmentation System

(Typical range shown)



Source: MITRE

received by the users. Using these measurements, information messages are created and sent to one or more satellites for broadcast to the end users.

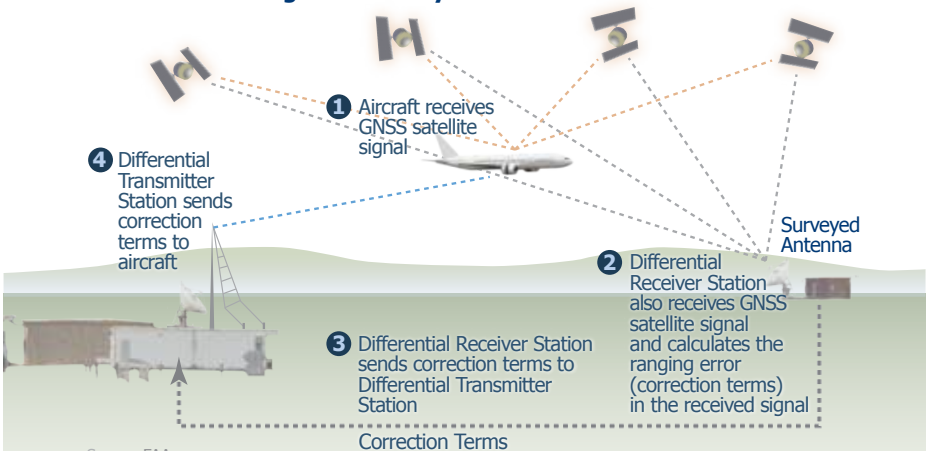
There are a number of SBASs operating in different parts of the world. SBAS based on GPS is available in North America (WAAS), Europe (EGNOS), and Japan (MSAS) and will soon be available in India (GAGAN) and in Russia (SDCM). Several thousand SBAS approach procedures are now implemented, mostly in North America, while other regions have started publishing SBAS-based procedures.

Ground-Based Augmentation System
The Ground-Based Augmentation System (GBAS) describes a system that supports augmentation through the use of terrestrial radio messages. As with the satellite based augmentation systems, ground based

augmentation systems are commonly composed of one or more accurately surveyed ground stations. They take measurements concerning GNSS, by one or more radio transmitters, which transmit the information directly to the end user. Generally, the GBAS networks are considered localised, supporting receivers within 20 kilometers around an airport, and transmitting in the VHF or Ultra High Frequency (UHF) bands.

In the United States system, this system is called a Local Area Augmentation System (LAAS). GBAS CAT I approaches based on GPS and GLONASS are available in Russia. SARPs for GBAS CAT II/III approaches are under operational validation. Related research and development activities are currently ongoing. It is also challenging for GBAS to support a high availability for precision approach, in particular in equatorial regions.

Ground-Based Augmentation System



Source: FAA

Surveillance

Secondary surveillance radars are used worldwide to track aircraft and provide independent cooperative surveillance. In the Block 0 time period, they continue to be the means for surveillance while aircraft are being equipped with ADS-B. In the Block 1 timeframe, ADS-B will become the primary mode of surveillance backed up by secondary surveillance radars. Fused ADS-B and radar data will be able to provide updates of aircraft position information every second.

Automatic Dependent Surveillance-Broadcast

ADS-B is a surveillance technology used for accurate tracking of aircraft. ADS-B will become the primary mode of surveillance for tracking aircraft worldwide with radars used

as a backup method. ADS-B can also provide traffic and graphical weather information through two different applications: Traffic Information Service, Broadcast mode (TIS-B) and Flight Information Service, Broadcast mode (FIS-B).

The aircraft broadcast information on position, velocity and intent is captured by appropriately located ground stations to provide coverage. ADS-B enhances safety by making an aircraft visible, in real-time, to ATC automation and other appropriately equipped ADS-B aircraft by providing them with accurate position and velocity data every second. ADS-B also provides the data infrastructure for inexpensive flight tracking, planning, and dispatch.

Information Management

In Block 0, SWIM will start to develop in the US and Europe. SWIM will provide operational services supported by Service Oriented Architecture (SOA) pioneer implementations. In the Block 1 time period, digital NOTAM and meteorological information will be widely implemented over the SWIM network. The SWIM deployment is expected to provide all participants on the ground and aircraft with access to a wide range of information and operational services.

SWIM

The ICAO Global ATM Operational Concept defines SWIM for sharing and integration of all ATM

information between ground automation systems for efficient air traffic planning and control. The future ATM system will rely on the evolution to a network-centric information environment in which the ground systems and the aircraft will function as a series of nodes that share information and relay their intent through a network of integrated systems. These systems are supported by a host of standard-compliant and interoperable services including interface management, messaging, security and enterprise service management on a multitude of platforms. A key component within SWIM is the transition of Aeronautical Information Systems

(AIS) to a modern digital environment providing Aeronautical Information Management (AIM). AIM offers a change from traditional paper-based and product-centric AIS to the data-centric and service-oriented information management that is fully integrated with other information domains in a SWIM environment. The goal of this transformation is more efficient management and rapid dissemination of all information relevant to ATM. Data and information, and their management is becoming more critical for safety and efficiency of air navigation. SWIM is one of the key elements of

US NextGen and European SES. It consists of standards, infrastructure and governance-permitting secure information exchange between ANSPs and airport operators to increase aircraft situational awareness for controllers via interoperable services. Development of the SWIM infrastructure for other ATM systems worldwide will continue in the future by the ANSPs and airports planning to implement ASBU capabilities. However, SWIM implementation will need to be locally or regionally tailored in accordance with individual service provider requirements.

Avionics Upgrades

In order to meet the requirements of the Efficient Flight Paths PIA, avionics upgrades will be needed to support optimised flight operations. The CNS avionics enhancements are discussed as follows.

In Block 0 the required equipage for data communication is the implementation of a VHF digital radio. The airborne Flight Management Systems (FMS) are being upgraded to support PBN applications using multi-sensor (DME, GNSS) navigation for flying RNAV routes. In Block 1, the required avionics will support digital communication via data link, and the aircraft with RNP-X capabilities will be able to use RNP-X certified approaches close to CAT I minima. A navigation specification that includes a requirement for on-board navigation performance monitoring

and alerting is referred to as an RNP-X specification. One not having such requirements is referred to as an RNAV specification.

The basic requirement for RNAV operations is that the aircraft has an approved GPS unit. In order for the aircraft to accurately navigate along a desired course, the GPS, integrated with FMS, should have an RNP capability. The RNP provides, in addition to RNAV, an onboard performance monitoring and alerting capability. A defining characteristic of RNP operations is the ability of the aircraft navigation system to monitor the navigation performance it achieves, and inform the crew if the path following requirement within the desired performance is not met during an operation. This onboard monitoring and alerting capability enhances the pilot's situation

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awareness and can enable reduced obstacle clearance. The ICAO PBN manual considers RNP application as a key part of efficient flight path design supporting homogeneous aircraft navigation from end to end.

An area navigation system capable of achieving the performance requirement (of an RNP-X specification) is referred to as an RNP avionics system. The RNP-X specification performance is defined as:

RNP: A measure of navigation performance accuracy and integrity (i.e., containment and time to alarm) necessary for aircraft operation within a defined airspace.

RNP-X

- A statement of lateral path conformance accuracy to 95%
- For example RNP-1

RNP Containment

- A definition of lateral containment limit equal to 2X RNP to a level of 99.999% accuracy

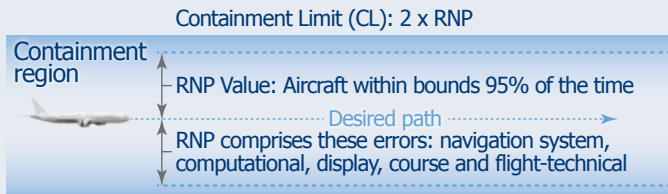
RNP systems provide improvements in the integrity of operation, permitting possibly closer route spacing, and can provide sufficient integrity to allow only the RNP systems to be used for navigation in a specific airspace. The use of RNP systems may therefore offer significant safety, operational and efficiency benefits. While RNAV and RNP applications will co-exist for a number of years, it is expected that there will be a gradual transition to RNP applications as the proportion of aircraft equipped with RNP systems increases and the cost of transition decreases.

The avionics will also include ADS-B Out receivers to broadcast aircraft information based on position measurements provided by GNSS to the ground stations and other aircraft. The ADS-B system relies on two avionics components:

1. A high-integrity GPS navigation source
2. A data link (ADS-B unit)

Required Navigation Performance (RNP)

A measure of navigation performance accuracy and integrity (i.e., containment and time to alarm) necessary for aircraft operation within a defined airspace.



Source: MITRE

6. Global Harmonisation Guiding Principles and Perspective

Aircraft operating today have increasingly advanced satellite- based CNS technologies. Harmonisation requires an aircraft to operate globally using standard operating procedures. In order to meet expectations for seamless, optimised flights, the future ATM system will need to be collaborative and it will require integration of humans, information, technologies, facilities and services within a framework of enhanced safety, efficiency, and capacity while ensuring continuity of services. It relies on using an integrated approach of a “system of systems” which must meet the global safety and efficiency objectives supported by the following guiding principles (Global Air Traffic Management Operational Concept, ICAO Doc 9854/AN/458, 2005).

Safety: The attainment of a safe system is the highest priority in air traffic management, and a comprehensive process for safety management is implemented that enables the ATM community to achieve efficient and effective outcomes.

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Safety: The attainment of a safe system is the highest priority in air traffic management, and a comprehensive process for safety management is implemented that enables the ATM community to achieve efficient and effective outcomes.

Humans: Humans will play an essential role in the global ATM system. Humans are responsible for managing the system, monitoring its performance and intervening, when necessary, to ensure the desired system outcome. Due consideration of human factors must be given to all aspects of the system.

Technology/Operational Capabilities: The ATM operational concept addresses the functions needed for ATM without reference to any specific technology or design, and is open to new and innovative technologies and design that meet minimum performance standards. CNS systems, ATM automation and decision support tools are used to

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integrate the ground-based and airborne system elements into a fully integrated, interoperable and robust ATM system. Adhering to performance standards allows flexibility across regions, homogeneous areas or major traffic flows to meet the requirements of the concepts defined in the modules of the Blocks.

Information: The ATM community will depend extensively on the provision of timely, relevant, accurate, accredited and quality-assured

information to collaborate and make informed decisions. Sharing information on a system-wide basis will allow the ATM community to conduct its business and operations in a safe and efficient manner.

Collaboration: The ATM system is characterised by strategic and tactical collaboration in which the appropriate members of the ATM community participate in the definition of the types and levels of service. Equally important, the ATM community collaborates to maximise system

The global harmonisation and interoperable system perspective requires that:

- Future air transportation system development issues are managed globally
- System improvements are deployed where and when needed, but based on common principles/rules/data and interoperable technologies
- Cooperation and collaboration among stakeholders is established early in the development life cycle and is efficient

Source: CANSO



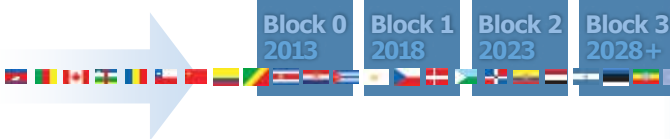
efficiency by sharing information, leading to dynamic and flexible decision making.

Continuity/Reliability:

The realisation of the concept requires contingency measures to provide maximum continuity of service in the face of major outages, natural disasters, civil unrest, security threats or other unusual circumstances. There will be a paradigm shift from current boundary orientation, (i.e., paying overflight fees based on Flight Information

Region [FIR] boundaries), to a future business orientation, allowing aircraft operators to maximise use of their business or optimum trajectories.

Paradigm shift to a business model changes disparate national systems into a universal one*



	Boundary-oriented	Business-oriented
Non-optimum	Traffic Flow	Optimum
Inefficient	Ground service for airlines and passengers	Efficient
Non-optimum	Flight profiles	Optimised
Limited	Utilisation of aircraft capabilities	Maximum
Air Traffic Control	Intervention from ground systems	Air Traffic Management
Unpredictable	Airport access	Predictable

*Countries' flags displayed are notional and not indicative of status in the ASBU process.

Source: MITRE

7. Global Performance Standards

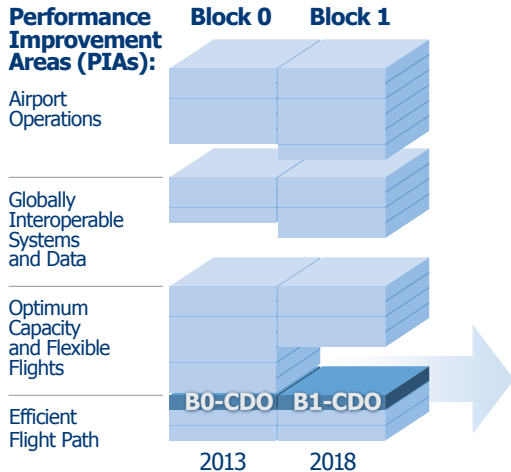
ICAO produces Standards and Recommended Practices (SARPs), Procedures for Air Navigation Services (PANS), Regional Supplementary Procedures (SUPPs) and Guidance Material. SARPs are formulated in broad terms and restricted to essential requirements. PANS are procedures for air navigation services comprising operating practices and material for air traffic safety and efficiency. SUPPs comprise material similar to PANS, but do not have worldwide applicability. Guidance Material is produced to supplement the SARPs and PANS, to facilitate their implementation.

The standards developed by other recognised international organisations can also be referenced provided they have been subjected to adequate verification and validation. The organisations that generally provide such standards are ARINC, EUROCAE, RTCA and SAE. These Standards bodies use a consensus process to work across industry with multiple stakeholders with competing interests to develop minimum operating and performance requirements. The standards produced by these Standard bodies provide a means of compliance, in most cases within a specific region (e.g., in the U.S. the FAA complies with RTCA standards) as well as with ICAO standards where referenced.

The standards produced by these internationally recognised organisations

can be used as the States implement modules in the ASBUs. The ICAO Global Standardization Roadmap (draft)³ provides standards for each of the Block 0 and Block 1 Modules. The following is an example of the standards available when implementing Block 0–Continuous Descent Operations (CDO). ICAO has documented an initial mapping of the standards available through the Block 1 time frame for CDO using VNAV, and is working with the standards bodies to ensure that the standards will also be available for Blocks 2 and 3.

The States, ANSPs and manufacturers are encouraged to participate in the work of the standards organisations in the development and updates of these standards. These standards are available on the following web sites: www.rtca.org and www.icao.int



Source: ICAO

Efficient Flight Path—Continuous Descent Operations (CDO)³

Block 0 Improved Flexibility and Efficiency in Descent Profiles (CDO)	Block 1 Improved Flexibility and Efficiency in Descent Profiles (CDO using VNAV)	Block 2 Improved Flexibility and Efficiency in Descent Profiles (CDO using VNAV, required speed and time at arrival)	Block 3 Full 4D Trajectory Based Operations
ICAO Doc. 4444 — Upd. <2013 ICAO Doc. 8168 — Pub. <2013 ICAO Doc. 9931 — Pub. <2013	ARINC ARINC 424 — Upd. TBD RTCA — TBD TBD RTCA — TBD TBD ICAO — TBD TBD TBD — TBD TBD FAA AC20-138C/AC20-129 — TBD 2018 EASA AMC20-27 — TBD 2018 RTCA DO-229D — TBD 2018 RTCA DO-236B — TBD 2018 RTCA DO-283A — TBD 2018 ICAO Doc. 9931 — TBD <2018 ED-75Brev/DO-236Brev — Upd. TBD	To be defined	To be defined

Module Number	Standard Title	Date of availability	Organisation	Action	Status
B0-CDO	Doc. 444 PANS ATM	<2013	ICAO	Upd.	Not Started
B0-CDO	Doc. 8168 PANS OPS	<2013	ICAO	Publ.	N/A
B0-CDO	Doc. 9931 Continuous Descent Operations (CDO) Manual	<2013	ICAO	Publ.	N/A
B1-CDO	ARINC 424 Standard	TBD	ARINC	Upd.	Not Started
B1-CDO	Standards for 4D capable ATM Systems	TBD	RTCA	TBD	Not Started
B1-CDO	Standards for 4D Capable aircraft avionics	TBD	RTCA	TBD	Not Started
B1-CDO	Standards for Pilot and ATCO Training for 4D Operations	TBD	ICAO	TBD	Not Started
B1-CDO	FMS Functionality/Database constraints	TBD	TBD	TBD	Not Started
B1-CDO	AC20-138C/AC20-129 credit?	2018	FAA	TBD	N/A
B1-CDO	AMC20-27	2018	EASA	TBD	N/A
B1-CDO	DO-229D, MOPS for Global Positioning System/Wide Area Augmentation System Airborne Equipment	2018	RTCA	TBD	N/A
B1-CDO	DO-236B, MASPS Required Navigation Performance for Area Navigation	2018	RTCA	TBD	N/A
B1-CDO	DO-283A, MOPS for Required Navigation Performance for Area Navigation	2018	RTCA	TBD	N/A
B1-CDO	Doc. 9931 Continuous Descent Operations (CDO) Manual	<2013	ICAO	TBD	N/A
B1-CDO	ED-75Brev/DO-236Brev, MASPS Required Navigation Performance for Area Navigation	TBD	EUROCAE/RTCA	Upd.	Started

Source: ICAO

8. ASBU Implementation Challenges

States and air navigation service providers have varying levels of ground systems and avionics capabilities. This creates several challenges. It is a challenge to upgrade multiple, legacy systems cost effectively in a timely manner. Each service provider will have a different timeframe for upgrading or implementing new systems, depending upon the needs and available financial resources. The following challenges must be addressed by the aviation community in order to meet interoperability and harmonisation requirements.

ASBU Capabilities' Dependencies on overcoming Implementation Challenges

The following are the specific capacity, efficiency, safety and policy challenges on which the successful implementation of ASBU capabilities depend. The ICAO, ANSPs, airports and aircraft operators will have to meet the implementation challenges of:

- a. Air/ground CNS technologies
- b. ATM automation and information management systems
- c. Policies and procedures for integration of RPSs with civil aircraft operations
- d. Environmental considerations for local communities.

Capacity, Delay and Environment

As traffic demand continues to grow in size, diversity and complexity, it will be a challenge to balance the conflicting requirements of increased

capacity with environmental impact in terms of reducing noise and emissions to meet the goals of enhanced efficiency through reduced delays.

CNS Technologies

As reliance on GNSS increases and because ADS-B surveillance depends on GNSS, the challenge is to ensure the reliability and integrity of navigation and surveillance services through backup systems. Standardisation of data communication services is also essential for global interoperability.

Cohesive Databases and Interfaces

Development of a cohesive set of databases and interfaces for global sharing of aircraft information for integrated terrestrial and satellite networks towards a common shared data network connecting all subsystems and systems.

Standard ATM Vocabulary and Format

Establishment of:

- a. A global ATM vocabulary for terms with clearly defined format (syntax) and meaning (semantics)
- b. Information exchange protocols and procedures so that the information does not change character, value and format as it flows from system to system.

Frequency Spectrum Compatibility

Frequency and spectrum for new transmitting and receiving equipment which ensures electromagnetic compatibility with

existing systems.

Human versus Ground Automation Decision Support

Currently ensuring aircraft separation depends on controllers' experience and skills that have an impact on airspace, sector and route design. Therefore it is essential to explicitly establish the role of human versus automation for delegating separation responsibility during normal and automation failure operations.

RPA Integration

Rules and operating procedures will be needed to allow RPA operations with other aircraft in shared airspace without adversely impacting the efficiency and safety of commercial traffic.

Global Performance Standards Implementation

For the interoperability of hardware and software systems worldwide so that the aircraft and ATM systems communicate flawlessly for continuity and consistency of service, it is critical that future technologies and systems are compatible. The challenge lies in establishing global performance standards for interoperability of air/ground systems worldwide.

Level of Aircraft Equipage

For achieving maximum benefits from implementing ASBU capabilities, a large number of aircraft will require avionics capable of Data comm, RNAV/RNP and ADS-B. This will require the aircraft operators to significantly invest in avionics upgrades that could result in long lead times. The challenge lies in establishing policies for financial

incentives and possible mandates.

Local Community Support

In order to consider local communities' environmental (noise) concerns about the operations at airports in their vicinity, policies are needed to guide decisions for implementing flight paths, departure and approach procedures based on ASBU implementation requirements.

Introduction to Aviation System Block Upgrades (ASBU)

ASBU Capabilities’ Dependencies on Overcoming Implementation Challenges

Out of the 17 capabilities in Block 1, about one-half (9 capabilities) have more than five implementation challenges, which require commitment by the ANSPs to plan for timely modules implementation.

■ = Capability will be impacted if ASBU Implementation challenge is not overcome

Block 1 ASBU Capability	Capacity, Delay and Environment	CNS Technologies	Cohesive Databases and Interfaces	Standard ATM Vocabulary and Format	Frequency Spectrum Compatibility	Ground Automation Decision Support	RPA Integration	Global Perf. Stds. Implementation	Level of Aircraft Equipage
Optimised Airport Accessibility*	■	■	■	■		■		■	■
Optimised Wake Turbulence Separation	■	■				■		■	■
Enhanced Safety and Efficiency of Surface Operations*	■	■	■	■	■			■	■
A-CDM Total Airport Management	■		■	■		■			■
Remotely Operated Aerodrome Control						■		■	
Departure, Surface, and Arrival Management*	■	■	■	■		■		■	■
Flight and Flow Information for Collaborative Environment		■	■	■		■		■	■
Integration of Digital ATM Information		■	■	■	■				
SWIM		■	■	■				■	
Integrated Meteorological Information	■	■	■	■					
Interval Management	■	■			■	■		■	■
Optimised ATS Routing	■	■						■	■
Network Operation Planning		■	■	■		■	■		
Ground-Based Safety Net		■	■	■		■			
Descent Profile Using VNAV	■	■						■	■
Integration of RPA	■	■	■	■		■	■	■	
Trajectory Based Operations	■	■	■	■			■	■	■

*Needs local community support.

Based on: Targeted NextGen Capabilities for 2025, Joint Planning and Development office, November 2011.

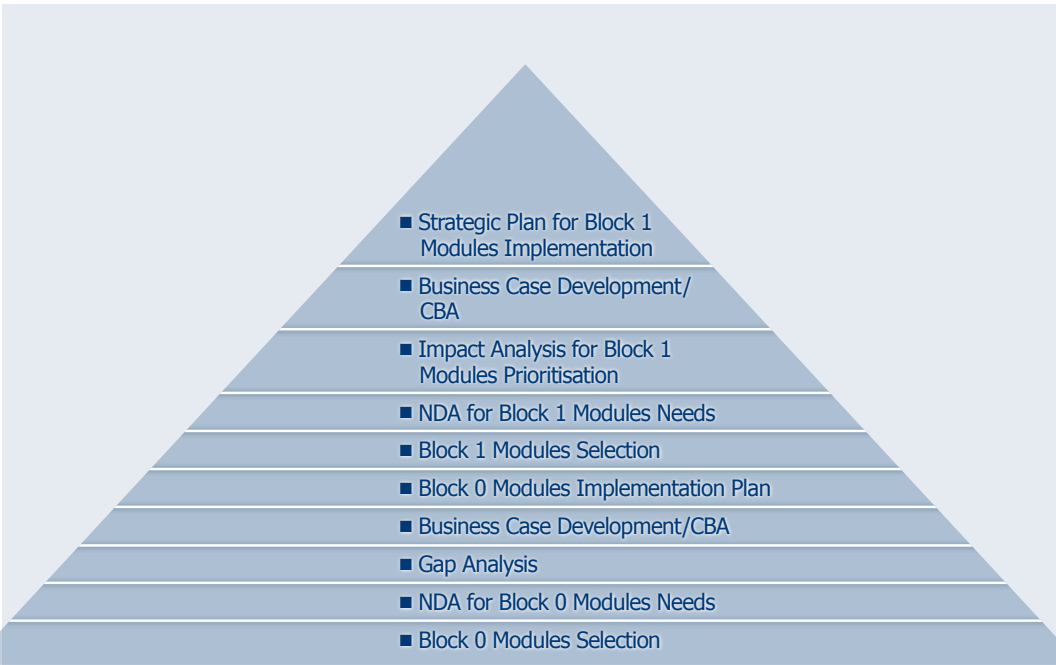
9. Strategic Planning for ASBU Modules Implementation

Each ANSP should develop a strategic plan to evolve its organisation's air transportation system capabilities to meet the goal of global harmonisation and interoperability. The ASBUs offer 18 modules in Block 0 and 17 modules in Block 1. Block 0 modules establish a foundation for progressing towards global harmonisation and interoperability.

Strategic Plan Development Steps

The following steps should be considered in order to develop a strategic plan for selecting, financing and implementing Block 0 and Block 1 modules over a specific time period.

- a. Select candidate Block 0 modules to meet organisational objectives (e.g., enhance capacity, reduce operating costs, etc.)
- b. Conduct a Needs and Dependency Analysis to determine the full set of needs including technology, equipment, procedures and training associated with the selected modules.
- c. Identify gaps between the Block 0 Module capabilities requirements and existing capabilities.
- d. Develop a business case based on cost/benefits analysis to close the gaps to make the current



Introduction to Aviation System Block Upgrades (ASBU)

- system compatible with Block 0 modules.
- e. Develop a Block 0 Modules implementation plan considering funding sources with a timeline.
- f. Select the Block 1 modules (at least the essentials) to make progress towards achieving global harmonisation.
- g. Conduct a Needs and Dependency Analysis to establish Block 1 Modules needs.
- h. Perform an impact analysis to prioritise Block 1 Module capabilities implementation.
- i. Develop a business case based on a cost/benefit analysis for selected Block 1 Modules implementation.
- j. Complete the strategic plan establishing a timeline for Block 1 Modules implementation based on available funding.

Needs and Dependency Analysis (NDA)

The NDA helps air navigation service providers determine which of the ASBU modules are right for their respective organisation. Not all ANSPs will need to implement all modules. The NDA assists the ANSP to determine the full set of needs – standards, technology, equipment, procedures, training, etc. – associated with each module.

The NDA further helps ANSPs determine the dependencies of modules on other modules. Sometimes an ANSP may not be able to implement a certain module unless other modules are already in

place. For example, some Block 1 Modules require implementation of Block 0 Modules as a prerequisite. This careful scrutiny of the modules establishes a detailed inventory of needs to implement the modules.

The NDA accomplishes the following:

- a. Identifies candidate ASBU modules that align with the service provider's strategic objectives for future growth and harmonisation
- b. Identifies the specific needs defined within those candidate modules
- c. Defines the dependencies with other ASBU modules
- d. Assesses what the individual provider's system currently has that meets the needs of the candidate modules
- e. Highlights the gaps that exist between current capabilities and the ASBU module needs
- f. Analyses the impacts of different means and timing of closing those gaps to meet the ICAO vision for global interoperability
- g. Investigates the linkage between modules and the potential costs involved by choosing not to implement a module in the early Blocks and then deciding to implement a module in the same thread in a later Block
- h. Determines the likely penalties for delaying essential capabilities beyond the recommended Block time frame
- i. Establishes the requirements for the new/upgraded modules and for planning the transition from Block 0 modules to Block 1 modules

- j. Assesses the current ability of the service provider's existing aviation system and identifies gaps and shortfalls
- k. Identifies areas where the service provider's capabilities are being performed at less than the desired ASBU performance level, or not at all
- l. Examines sources of information such as lessons learned, government contracted studies and documents that could validate shortfalls and gaps in order to make appropriate decisions to overcome limitations

Gap and Impact Analyses

Since each organisation will most likely already have met some of the Block 0 Modules needs, it is important to determine what capabilities exist and do not need to be considered using a gap analysis. The difference between what exists and the full set of needs is the gap that remains to be filled.

There are many possible methods to close the gaps to meet the organisation's goals. An impact analysis can show the differing effects of those possible methods. For example, additional runways may be an alternative to new procedures that permit more closely spaced arrivals and departures.

The difference between the degree to which a service provider needs to upgrade its capabilities versus how well the service provider is able to develop and deploy the

needed module upgrades with the desired timeframe is considered in an Impact Analysis. The impacts of implementing the various modules, infrastructure (air and ground), procedures and training contained in the candidate modules are qualitatively defined based on the amount of contribution they make to meet the desired performance objective. The four levels of impact are:

1. **No impact:** There is no contribution to achieving the desired improvements over the intended time period. This does not necessarily mean that there is no utility, but may mean that the service provider's current ability is performing so poorly that the evolutionary upgrades may not be cost effective at this time.
2. **Limited impact:** There is a limited improvement to meet the desired objectives in the selected time period.
3. **High impact:** Offers satisfactory improvement to meet the desired objectives within the expected timeframe.
4. **Redundant impact:** Provides improvement in proficiency beyond what is needed for the planned time period, or the improvement levels may be achieved by other means.

Business Case Development Process

Although the appropriate selection of minimum path required modules is necessary, it is not sufficient without a justification based on Cost/Benefit Analysis (CBA) to support the development of a business case.

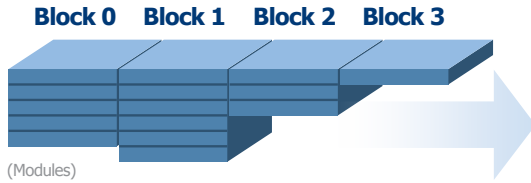
The business case development process evaluates the alternative ASBU modules, selected through the Needs and Dependency Analysis (NDA), by estimating the costs and benefits of each through the estimated life of the investment and

identifies implementation priorities. The business case for the ASBU alternative modules is unique, because it entails evaluating the cost and benefit implications from a multi-stakeholder perspective, and the implications of the alternative ASBU modules on the future aviation system and its participants. It is not just one business case, but rather there are multiple business cases, one for each important stakeholder (listed in the chart on the next page). Different stakeholders have

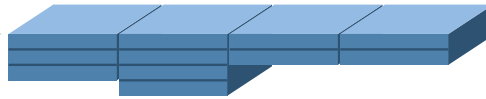
Identify Scope

Performance Improvement Areas (PIAs):

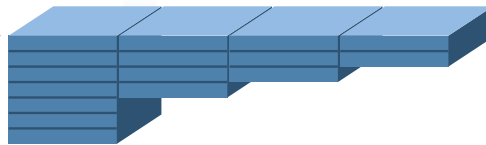
Airport Operations



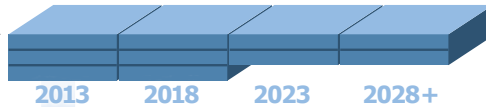
Globally Interoperable Systems and Data



Optimum Capacity and Flexible Flights



Efficient Flight Path



Alternatives

Subset of improvements – to be modeled in the benefits analysis and to develop cost estimates

very different investment decision criteria. When presented with a set of business case results, stakeholders interpret those results based on their own needs. What appears to be a great business investment to an ANSP may be dismissed as a bad business case by a commercial operator. A business case analysis framework is needed that supports a joint evaluation of investments.

Key Stakeholders Include:

- Air Navigation Service Providers
- Commercial Airlines

- Airports
- General Aviation
- Military Operations
- Society

Key Performance Measures Include:

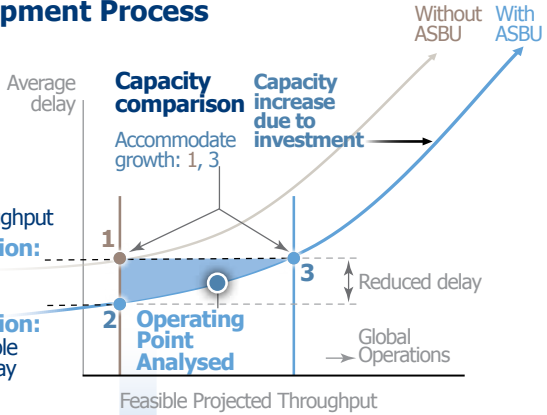
- Flight time or Delay Saved
- Increase in the Number of Flights
- Reduction in Fuel and Emissions
- Decreased Maintenance Costs
- Predictability: Reduction in diversions/cancellations

Business Case Development Process

Assess Benefits

- Run forecast simulations to estimate monetised and non-monetised benefits of ASBU alternatives.

- 1 **Without investment:**
Baseline projected delay/throughput
- 2 **After ASBU implementation:**
Reduced delay possible for unchanged throughput
- 3 **After ASBU implementation:**
Increased throughput is possible with no additional average delay

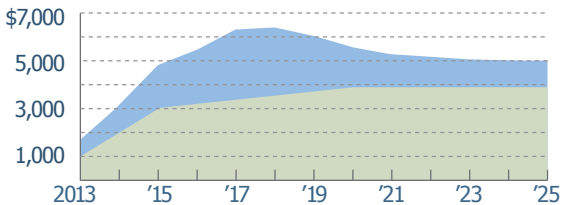


Assess Costs

- Aggregate all lifecycle costs (capital and operating costs) for ASBU-related programs and activities.
- Apply uncertainty analysis to develop cost ranges.

Legacy and ASBU Expenditures Forecast

Additional ASBU costs, in \$millions
 ■ Capital Costs
 ■ Operating Costs



Funding Sources

In order for an aviation service provider to select and implement the ASBU modules, it must have the required funding. The aviation service provider should develop a business case to estimate the amount of funds it needs to invest in the selected ASBU modules to meet its operational requirements for multiple years, and adjust its budget planning needs to match the amount. This should be based not only on capital needed for purchasing and deploying the appropriate equipment, but also considering costs for labour including training, operations and maintenance over time. Purchasing and implementing a subset of modules may not provide the desired benefits, as would establishing and following a careful plan to implement the full set of ASBU modules. Mostly, the State governments provide funds to enhance the air transportation system. Recently, a number of ANSPs have privatised services. The following paragraph discusses the option for funding sources other than provided by the State government through private partnership.

Funding via Public/ Private Partnership (PPP)

PPP is a business venture which is funded and operated through a partnership between the government and the private sector. It involves an agreement between a public sector authority and a private party. The private party provides a public service or project development, and assumes substantial financial, technical, and operational risk. In some types of PPP, the cost is borne exclusively by the users of the service and not by the taxpayer.

In other types of PPP, capital investment is made by the private sector on the strength of an agreement with the government to provide the agreed services, and the cost is borne wholly or in part by the government. In the infrastructure sector, complex arrangements and contracts that guarantee and secure the cash flows, make PPP projects prime candidates for project financing. In the case of a service provider planning an acquisition of an ASBU module, such a partnership can provide up-front funds for system development. These funds could be repaid through the user fees over a period of time.

Strategic Implementation Plan Development

Each service provider will need to develop a strategic implementation plan for the development and implementation of ASBU modules based on an investment strategy that considers impact assessment to priorities, capabilities and the available funding within the desired time frame. The Impact Analysis is an important input to the Cost- Benefit Analysis and Business Case development that justifies the strategic implementation plan.

Because implementation of the ASBU modules requires investment, not only on the part of the ANSP, but also those who operate in its airspace, best practices call for collaboration between the ANSP, airport and aircraft operators in setting a time frame for each Block Modules' implementation. There must be a positive business case for both the ANSP and the operators for each module.

References

1. *2013-2028 Global Air Navigation Plan*, Doc. 9750 – AN/963 Fourth Edition – 2013
2. *Global Air Traffic Management Operational Concept*, ICAO Doc 9854 AN/458, First Edition – 2005
3. *Draft Global Standardization Roadmap*, Version 0.50, 22nd February, 2013

Abbreviations

- 4D:** Four-Dimensional (operations with time requirements)
- 4D TBO:** Four-Dimensional TBO (TBO with time requirements)
- A-CDM:** Airport Collaborative Decision Making
- ADS-B:** Automatic Dependant Surveillance-Broadcast
- ADS-C:** Automatic Dependant Surveillance-Contract
- AMAN/DMAN:** Arrival Management/Departure Management
- ANC:** Air Navigation Commission
- ANSP:** Air Navigation Service Provider
- ARINC:** Aeronautical Radio Incorporated
- A-SMGCS:** Advanced Surface Movement Guidance Control System
- ATC:** Air Traffic Control
- ATM:** Air Traffic Management
- ATS:** Air Traffic Services
- CANSO:** Civil Air Navigation Services Organisation
- CARATS:** Collaborative Actions for Renovation of Air Transport Systems
- CAT:** Category
- CCO:** Continuous Climb Operations
- CDM:** Collaborative Decision Making
- CDO:** Continuous Descent Operations
- CNS/ATM:** Communications, Navigation, and Surveillance/ Air Traffic Management
- CNS:** Communication, Navigation and Surveillance
- DME:** Distance Measuring Equipment
- EASA:** European Aviation Safety Agency
- EGNOS:** European Geostationary Navigation Overlay Service
- EUROCAE:** European Organization for Civil Aviation Equipment
- FAA:** Federal Aviation Administration
- FF-ICE:** Flight and Flow-Information Collaborative Environment
- FIANS:** Future India Air Navigation System
- FMS:** Flight Management System
- GAGAN:** GPS Aided GEO Augmented Navigation
- GANP:** Global Air Navigation Plan

GEO: Geostationary Satellite

GLONASS: Russian form of GNSS

GNSS: Global Navigation Satellite System

GPS: Global Positioning System

HF: High Frequency

HFDL: High Frequency Data Link

ICAO: International Civil Aviation Organization

ILS: Instrument Landing System

LORAN: Long Range Navigation

MASPS: Minimum Aviation System Performance Standards

MLAT: Multilateration

MSAS: MTSAT Satellite-based Augmentation System

MTSAT: Multifunctional Transport Satellite

NDA: Needs and Dependency Analysis

NDB: Non-Directional Beacon

NOTAM: Notice to Airmen

PANS ATM: Procedures for Air Navigation Services Air Traffic Management

PANS OPS: Procedures for Air Navigation Services Aircraft Operations

PBN: Performance Based Navigation

PIA: Performance Improvement Area

PIRG: Planning and Implementation Regional Group

RNAV: Required Navigation Performance and Area Navigation

RNP: Required Navigation Performance

RNP-X: Required Navigation Performance with 95% X nmi lateral accuracy

RPA: Remotely Piloted Aircraft

RTA: Required Time of Arrival

RTCA: Radio Technical Commission for Aeronautics

SAE: Society of Automotive Engineers

SARP: Standards and Recommended Practices

SATCOM: Satellite Communications

SBAS: Satellite-Based Augmentation System

SDCM: System of Differential Correction and Monitoring

SES: Single European Sky

SIRIUS: Brazil's ATM Automation System

SSB: Single Sideband

SWIM: System Wide Information Management

TBO: Trajectory-Based Operations

VDL: VHF Data Link

VHF: Very High Frequency

VNAV: Vertical Navigation

VOR: Very High Frequency Omnidirectional Range

WAAS: Wide Area Augmentation System

WAM: Wide Area Multilateration

