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INTERNATIONAL CIVIL AVIATION ORGANIZATION

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OVERVIEW OF THE APPLICABLE CNS ASBU ELEMENTS

Introduction

ASBU FRAMEWORK AND THREAD

ASUR ASBU ELEMENTS

COMI ASBU ELEMENTS

COMS ASBU ELEMENTS

NAVS ASBU ELEMENTS

Introduction

ASBU FRAMEWORK

ASBU Block

Specific concept of operations.

Deadline for an element to be available for implementation.

ASBU Thread

Key feature area of the air navigation system.

ASBU Element

A specific operational improvement

ASBU Enabler

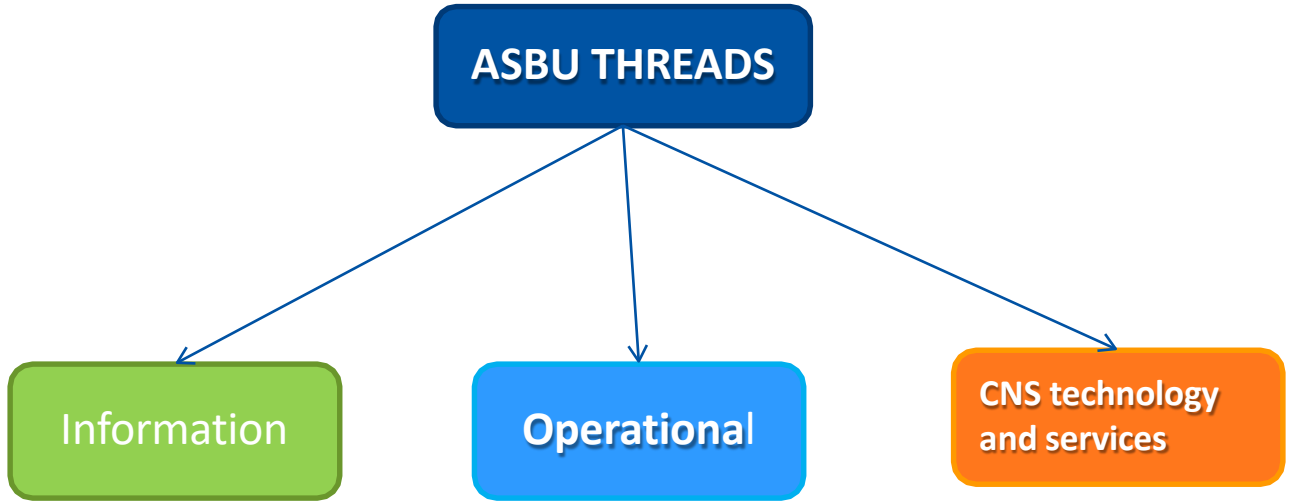
Component (standards, procedures, training, technology,…)

ASBU Module

A group of elements from a thread.

ASBU THREADS

- Another key concept in the updated framework.
- The ASBU threads already existed in previous versions of the GANP and they were key feature areas of the air navigation system where improvements are needed to achieve the vision outlined in the Global ATM Operational Concept.
- The ASBU threads are been categorized in 3 groups:
  - Operational threads: ACDM, APTA, NOPS…
  - Information threads: SWIM, AMET, DAIM, FICE,…
  - Technology threads: ASUR, COMI, COMS and NAVS



CNS TECHNOLOGY AND SERVICES

ASBU CNS MODULES		
ASUR	Surveillance systems	Technology
COMI	Communication infrastructure	Technology
COMS	ATS Communication service	Technology
NAVS	Navigation systems	Technology

ASBU Block	Timeframe (Availability for Implementation)
Block 0 (B0)	From 2013
Block 1 (B1)	From 2019
Block 2 (B2)	From 2025
Block 3 (B3)	From 2031
Block 4 (B4)	From 2037

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ASUR ASBU ELEMENTS

ELEMENTS

Element ID	Title
ASUR-B0/1	Automatic Dependent Surveillance – Broadcast (ADS-B)
ASUR-B0/2	Multilateration cooperative surveillance systems (MLAT)
ASUR-B0/3	Cooperative Surveillance Radar Downlink of Aircraft Parameters (SSR-DAPS)
ASUR-B1/1	Reception of aircraft ADS-B signals from space (SB ADS-B)
ASUR-B2/1	Evolution of ADS-B and Mode S
ASUR-B3/1	Performance-based surveillance requirements for middle levels
ASUR-B3/2	Performance-based Surveillance Requirements for Lowest Airspace Operations (LAO)
ASUR-B3/3	Performance-based Surveillance Requirements for Higher Airspace Operations (HAO)
ASUR-B4/1	Further evolution of ADS-B and MLAT

ASUR-B0/1	Automatic Dependent Surveillance – Broadcast (ADS-B)	Technology

Main Purpose:

To support the provision of Air Traffic Services and operational applications at reduced cost and increased surveillance coverage.

New capabilities:

ADS-B provides precise position/velocity information in all airspace (accuracy not range-dependent as with radar)'It also provides aircraft call sign and precise position/velocity information to nearby aircraft with ADS-B-in receivers.

ADS-B can also support State aircraft airspace access, however it should, when possible, leverage benefits from dual-use of State aircraft capabilities to reduce cost and technical impact.

Description:

ADS-B provides an aircraft's identification, position, altitude, velocity, and other information to any receiver (airborne or ground) within range. The broadcasted aircraft position/velocity is normally based on the global navigation satellite system (GNSS) and transmitted at least once per second.

Maturity Level: Ready for implementation
Human Factor Consideration
Planning Layers: Tactical during ops
Operations: Taxi-out, Departure, En-route, Arrival, Taxi-in
Dependencies and relations

Type of Dependencies	ASBU Elements
Relation operational need	NAVS- B0/3 – Aircraft Based Augmentation System (ABAS)
Relation - benefit: NAVS- B0/2- Satellite Based Augmentation System (SBAS)	

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ASUR-B0/2 Multilateration cooperative surveillance systems (MLAT) Technology

Main Purpose: To provide an alternative to radar surveillance by using available aircraft transponders.

New capabilities: MLAT allows cooperative surveillance in rough terrain with an in mountainous regions or on airport surfaces where surveillance systems requiring a rotating radar dish had performance difficulties. It may also be integrated with ADS-B ground stations to provide a surveillance capability that is more resilient to GNSS function failure.

Description:

MLAT is a new technique providing independent cooperative surveillance. The MLAT system interrogates an aircraft, and the transponder reply is received by multiple receivers located in different places. The reply's times of arrival difference at the receivers allows the position of the source of signals to be determined, with an accuracy that is dependent on the number of receivers and their location relative to the aircraft. MLAT systems do not require a rotating radar dish and were initially deployed on airports to provide surface surveillance of aircraft. The technique is now used to provide surveillance over wide area (wide area MLAT system - WAM), sometimes in conjunction with ADS-B. MLAT requires more ground stations than ADS-B but has the early implementation advantage of using existing aircraft transponders.

Maturity Level: Ready for implementation

Human Factor Consideration:

Planning Layers: Tactical During ops

Operations: Taxi-in, Departure, En-route, Arrival, Taxi-in

Dependencies and relations: There are currently no dependencies

ASUR-B0/3 Cooperative Surveillance Radar Downlink of Aircraft Parameters (SSR-DAPS) Technology

Main Purpose:

To obtain additional information from an aircraft transponder in support of the provision of Air Traffic Services.

New capabilities: SSR-DAPS enables ATM systems to obtain additional information from an aircraft transponder, via interrogation by a cooperative surveillance system (Mode S radar or MLAT). This additional information can be used to increase controller awareness and reduce the volume of air-ground voice communications, and/or to improve the performance of tracking systems or safety net systems such as STCA and MSAW.

Description:

Downlink of Aircraft Parameters (DAPS) includes both Controller Access Parameters (CAPs) and System Access Parameters (SAPs). Possible CAPs include Magnetic Heading, Indicated Airspeed / Mach Number, Barometric rate of climb/descent, and Selected Altitude (which can also be consider a SAP). SAPs include Roll Angle, Track Angle Rate, True Track Angle, and Barometric Pressure Setting.

Maturity Level: Ready for implementation

Human Factor Consideration

Planning Layers: Tactical during ops

Operations: Departure, En-route, Arrival

Dependencies and relations: There are currently no dependencies

ASUR-B1/1 Reception of aircraft ADS-B signals from space (SB ADS-B) Technology

Main Purpose: To provide surveillance coverage in locations where ground stations siting is not possible or not currently provided.

New capabilities: SB ADS-B provides precise position/velocity information in airspace where it is not cost-effective or even feasible to place ground surveillance infrastructure.

Description:

ADS-B provides an aircraft's identification, position, altitude, velocity, and other information to a receiver on an orbiting satellite. The broadcasted aircraft position/velocity is normally based on the global navigation satellite system (GNSS) and transmitted at least once per second. Aircraft ADS-B signals are received on one or more orbiting satellites, and this information is passed through a data network to a Service Delivery Point at an Air Traffic Service facility (or facilities).

Maturity Level: Ready for implementation

Human Factor Consideration:

Planning Layers: Tactical during ops

Operations: Departure, En-route, Arrival

Dependencies and relations:

Type of Dependencies	ASBU Element
Evolution	ASUR-B0/1 - Automatic Dependent Surveillance – Broadcast (ADS-B)
Relation-operational need	NAVS-B0/3 - Aircraft Based Augmentation Systems (ABAS)
Relation-benefit	NAVS-B0/2 - Satellite Based Augmentation Systems (SBAS)

ASUR-B2/1 Evolution of ADS-B and Mode S Technology

Main Purpose: To provide new types of data in support of Air Traffic/MET services and vehicle-to-vehicle applications.

New capabilities: New aircraft/atmospheric information is provided via ADS-B and/or cooperative radar interrogation to support emerging ANSP/MET and vehicle-to-vehicle applications in an early TBO environment.

Description: RTCA and EUROCAE are working jointly to prepare the next version of the Mode S transponder MOPS and the ADS-B MOPS. Changes include correction of issues identified since the MOPS were last published, to support new collision avoidance systems, to support new Detect and Avoid systems, to support AD-B-In Interval Management application, to support potential commercial space operations (in the atmosphere), to reduce 1090 MHz spectrum congestion, to downlink certain meteorological parameters, to improve ADS-B reception performance, and to remove unused capabilities. Within, this timeframe, ADS-B vehicle-to-vehicle applications are potentially provided in a different spectrum in lower airspace.

This evolution offers opportunities for compliance based on performance-equivalence for State aircraft.

Maturity Level: Ready for implementation

Human Factor Consideration

Planning Layers: Tactical during ops

Operations: Taxi-out, Departure, En-route, Arrival, Taxi-in

DEPENDENCIES AND RELATIONS

Type of Dependencies	ASBU Element
Evolution	ASUR-B0/1 - Automatic Dependent Surveillance – Broadcast (ADS-B)
Evolution	ASUR-B0/2 - Multilateration cooperative surveillance systems (MLAT)
Evolution	ASUR-B0/3 - Cooperative Surveillance Radar Downlink of Aircraft Parameters (SSR-DAPS)
Evolution	ASUR-B1/1 - Reception of aircraft ADS-B signals from space (SB ADS-B)
Relation-operational need	NAVS-B0/3 - Aircraft Based Augmentation Systems (ABAS)
Relation-benefit	NAVS-B0/2 - Satellite Based Augmentation Systems (SBAS)
Relation-benefit	NAVS-B2/2 - Dual Frequency Multi Constellation (DF MC) SBAS
Relation-benefit	NAVS-B2/3 - Dual Frequency Multi Constellation (DF MC) ABAS - 2D

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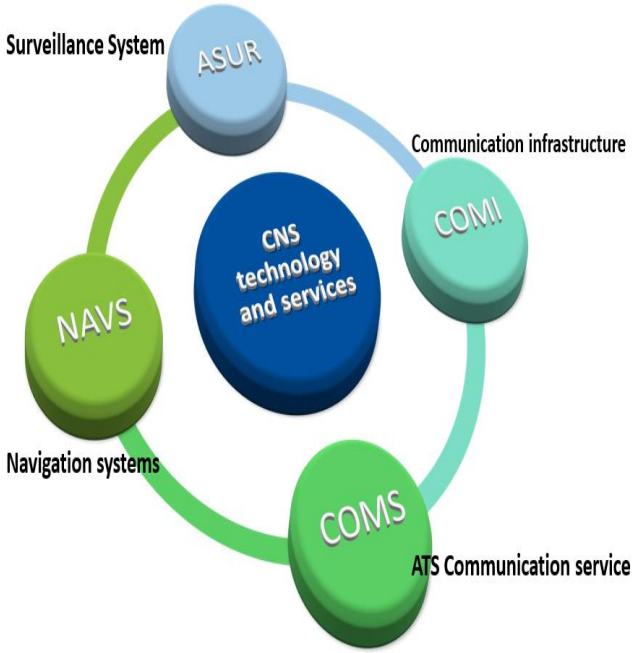
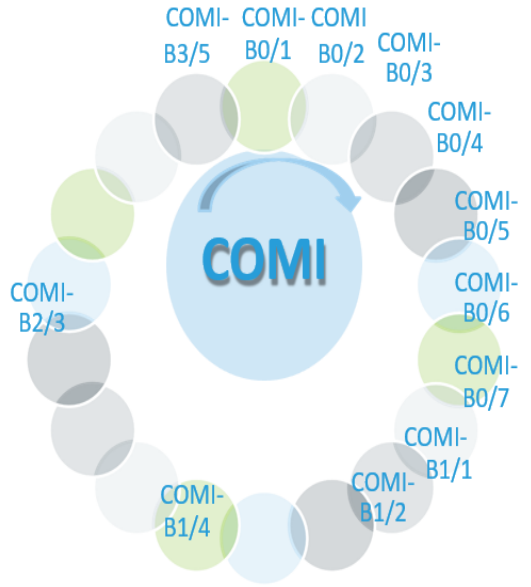
COMI ASBU ELEMENTS

COMI	Communication infrastructure	Technology





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COMI-B0/1 Aircraft Communication Addressing and Reporting System (ACARS) Technology

Main Purpose: The Aircraft Communications Addressing and Reporting System (ACARS) is a digital datalink system for transmission of messages between aircraft and ground stations via VHF or satellites.

New capabilities: ACARS provides the network for the controller and pilot with the ability to exchange datalink messages and thus provides a backup to voice communications. It also provides for airline operational control messaging.

Description: ACARS is a digital datalink network system which transmits and routes messages between aircraft and ground stations via VDL Mode 0/Mode2 radios or satellites.

Maturity Level: Ready for implementation

Human Factor Consideration

Planning Layers: Tactical during ops

Operations: Taxi-out, Departure, En-route, Arrival, Taxi-in

Dependencies and relations

Type of Dependencies	ASBU Element
Relation-technology option	COMI-B0/3 - VHF Data Link (VDL) Mode 0/A
Relation-technology option	COMI-B0/4 - VHF Data Link (VDL) Mode 2 Basic
Relation-technology option	option COMI-B0/5 - Satellite communications (SATCOM) Class C Data
Relation-technology option	COMI-B0/6 - High Frequency Data Link (HFDL)

COMI-B0/2	Aeronautical Telecommunication Network/Open System Interconnection (ATN/OSI)	Technology

Main Purpose: ATN/OSI provides a bit-oriented multi-layer protocol for exchanging ATS messages between the aircraft and ground system.

New Capabilities The ATN/OSI provides an alternative, dedicated ATS protocol for exchanging flight safety messages.

Description: The ATN/OSI provides a dedicated ATS communications protocol for the usage of B1 data link applications (e.g. CPDLC and Crew Member (CM)).

Maturity Level: Ready for implementation

Human Factor Consideration

Planning Layers: Tactical during ops

Operations: Taxi-out, Departure, En-route, Arrival, Taxi-in

Dependencies and relations

Type of Dependencies	ASBU Element
Relation-technology benefit	COMI-B1/2 - VHF Data Link (VDL) Mode 2 Multi-Frequency
Relation-technology benefit	COMI-B3/5 – SATCOM Class B Voice and Data
Relation-technology benefit	COMI-B3/1 – VHF Data Link (VDL) Mode 2 connectionless
Relation-technology need	COMI-B0/4 - VHF Data Link (VDL) Mode 2 Basic

COMI-B0/3	VHF Data Link (VDL) Mode 0/A	Technology

Main Purpose: VDL Mode 0/A (Old ACARS) is a data communications subnetwork that supports transmission of data link messages.

New capabilities:

- Introduction of a datalink to support domestic data communications operations.
- a supplement to voice communications
- Exchanges aviation data (AOC, CPDLC and ADS)

Description: VDL Mode 0/A is a narrow-band transceiver operating in the VHF aviation protected spectrum band which will transmit data to and from the aircraft to support data communications. The VHF digital radio system is based on the double side band AM multi-shift keying modulation to transfer 2400 bps.

Maturity Level: Ready for implementation

Human Factor Consideration

Planning Layers: Tactical during ops

Operations: Taxi-out, Departure, En-route, Arrival, Taxi-in

Dependencies and relations: There are currently no dependencies.

COMI-B0/4 VHF Data Link (VDL) Mode 2 Basic Technology

Main Purpose: VDL Mode 2 Basic is a data communications subnetwork that supports transmission of data link messages. It provides higher performance than VDLM0/A.

New Capabilities:

- Provides an Increase in data capacity over VDL Mode O/A
- Exchanges aviation data (AOC, CPDLC and ADS)
- More efficient use of spectrum

Description:

VDL Mode 2 is narrow-band transceiver operating in the VHF aviation protected spectrum band, which will transmit data to support data communications between the aircraft and ground. It consists of a set of air-ground protocols that increase the data rate to 31.5 kbits.

Maturity Level: Ready for implementation

Human Factor Consideration

Planning Layers: Tactical during ops

Operations: Taxi-out, Departure, En-route, Arrival, Taxi-in

Dependencies and relations

Type of Dependencies	ASBU Element
Evolution	COMI-B0/3 - VHF Data Link (VDL) Mode O/A

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COMI-B0/5 Satellite communications (SATCOM) Class C Data Technology

Main Purpose: To provide surveillance and communications where VHF usage is not possible or practical.

New Capabilities: Supports improvement of surveillance and communication in airspace where procedural separation is being applied.

Description:

Satellite-based, narrow-band communication provided by multiple service providers that can be used for safety and routing communications.

Maturity Level: Ready for implementation

Human Factor Consideration:

Planning Layers: Tactical during ops

Operations: Taxi-out, Departure, Arrival

Dependencies and relations: There are currently no dependencies.

COMI-B0/6	High Frequency Data Link (HFDL)	Technology

Main Purpose: To communicate in areas where SATCOM and VHF are not available.

New Capabilities:

- HFDL is a communications media used to exchange data messages between aircraft end-systems and corresponding ground-based HFDL ground stations.
- Supports improvement of surveillance in airspace where procedural separation is being applied.

Description:

The HFDL includes the HFDL network and avionics. Specifically, this means the introduction of an airborne communications router (e.g. Communications Management Unit) and an HFDL radio.

Maturity Level: Ready for implementation

Human Factor Consideration:

Planning Layers: Tactical during ops

Operations: En-route

Dependencies and relations: There are currently no dependencies.

COMI-B0/7 ATS Message Handling System (AMHS) Technology

Main Purpose: Supports improved communication over AFTN Provide flight information coordination between ANSPs at adjacent FIRs, and with relevant military units, support separation assurance, potentially providing, when used in conjunction with other enablers (e.g. navigation capabilities), reduced separation.

New Capabilities: New Capabilities AMHS makes use of higher speed communication than AFTN. It also allows the use of bit-oriented communications allowing greater flexibility in message types. Attachments to messages can also be supported thus allowing the exchange of graphics. Provides direct communication between adjacent FIRs using data communication to minimize the use of voice communication.

1. Increase performance to handle large files
2. Implement AFTN/AMHS gateway
3. Initiate the standardization of IP interface and addressing scheme.

Description: The AMHS is served as ICAO mandated communication for data exchange between ANSPs (ICAO Doc. 9880 and Annex X). AMHS is served as enabler for

1. Flight Plan/Clearance
2. AIDC: Flight transfer
3. MET data

ATS voice service is used for emergency coordination and/or normal coordination when data communication service is not available. AMHS is expected to be utilized to carry traf c for AIDC/Flight Plan/MET until SWIM is ready in Block 2. This is due to ANSPs need time to upgrade/implement adaptors to support SWIM interface. In the meantime, AMHS will accommodate SWIM compliance data message (IWXXM) as required. It is noted that AMHS would not be able to support FF-ICE and FIXM data.

The interface is based on IP over legacy dedicated point-to-point circuits

COMI-B0/7 ATS Message Handling System (AMHS) Technology

Maturity Level: Ready for implementation

Human Factor Consideration:

Planning Layers: Tactical during ops

Operations: Departure, En-route, Arrival

Dependencies and relations:

Type of Dependencies	ASBU Element
Relation-technology benefit	COMi-B1/1- Ground-Ground Aeronautical Telecommunication Network/Internet Protocol Suite (ATN/IPS)

COMI-B1/1 Ground-Ground Aeronautical Telecommunication Network/Internet Protocol Suite (ATN/IPS) Technology

Main Purpose: To provide for a more modern, more efficient, cost-effective, and robust data communications network infrastructure.

New Capabilities: New Capabilities It enables the efficient integration of technologies with improved integrity to support future air to ground aeronautical safety services and regularity of flight communications.

Description: The ATN/IPS internetwork consists of IPS nodes and networks operating in a multinational environment in support of Air Traf c Service Communication (ATSC) as well as Aeronautical Industry Service Communication (AINSC), such as Aeronautical Administrative Communications (AAC) and Aeronautical Operational Communications.

This evolution will support enhanced civil-military cooperation and coordination functions, if interoperability and military information security aspects are considered.

Maturity Level: Ready for implementation

Human Factor Consideration:

Planning Layers: Tactical during ops

Operations: En-route

Dependencies and relations:

Type of Dependencies	ASBU Element
Relation-technology benefit	COMi-B1/4- Aeronautical Mobile Airport Communication System (AeroMACS)

COMI-B1/2 VHF Data Link (VDL) Mode 2 Multi-Frequency Technology

Main Purpose:

- Supports transmission of data link message sets to supplement current voice operations, thus reducing voice channel congestion; while increasing productivity and capacity.
- Supports increased subnetwork capacity and reduces interference over the standard VDL Mode 2 system.

New Capabilities:

- Provides an increase in data capacity over VDL Mode 2
- Exchanges aviation data (AOC, CPDLC and ADS)
- Provides a supplement to voice communications
- More efficient use of spectrum

Description: VDL Mode 2 Multi-Frequency consists of a set of air-ground protocols that increase the data rate to 31.5 kbits. It allows transmission from a character-oriented protocols to digital or bit-based protocols while using VHF air and ground narrow-band transceiver operating in the VHF aviation protected spectrum band, which will transmit textual data to and from the cockpit to support data communications between the pilot and the air traffic controller.

Maturity Level: Ready for implementation

Human Factor Consideration:

Planning Layers: Tactical during ops

Operations: Taxi-off, Departure, En-route, Arrival and Taxi-in

Dependencies and relations:

Type of Dependencies	ASBU Element
Evolution	COMI-B0/4- VHF Link (VDL) Mode 2 Basic

COMI-B1/4 Aeronautical Mobile Airport Communication System (AeroMACS) Ground-Ground Technology

Main Purpose:
- Reduced Separation
- Improved situational awareness
- Reduced Cost
- Improved Efficiency

New Capabilities:
- Broadband Communications
- Supports Safety communications
- IPS Based System
- Improved Security

Description: AeroMACS is a broadband wireless communications system. It can provide network connectivity on the airport surface for wireless communications and can be used only for the safety critical and regularity of flight. The assests supported by AeroMACS include multilateration sensors, weather sensors, surface radar, fixed navigation aids, aircraft, emergency vehicles and baggage trucks.

Maturity Level: Ready for implementation
Human Factor Consideration:
Planning Layers: Tactical during ops
Operations: Taxi-off, Taxi-in
Dependencies and relations: There are currently no dependencies.

COMI-B2/3	Links meeting requirements for non-safety critical communication	Technology

Main Purpose To:
- reduce operational cost;
- improve performance;
- take advantage of new technologies sooner;
- enable the global exchange of non-safety information.

New Capabilities:
- Improved resiliency
- Reduced operational costs
- Improved capacity Broadband communications
- Enable a single IP-based global operating network

Description: Broadband satellite and cellular services are used to support non-safety critical communications. By adopting the use of available infrastructure and possibly the use of a multi-sensor concept these systems meet performance requirements, in effect leading to reduced system cost, while improving the overall performance of the network and the system resiliency.

Maturity Level: Ready for implementation
Human Factor Consideration:
Planning Layers: Tactical during ops
Operations: Taxi-off, Departure, En-route, Arrival and Taxi-in
Dependencies and relations: There are currently no dependencies.

COMI-B3/5 SATCOM Class B Voice and Data Technology

Main Purpose:

- Supports introduction of SATVOICE and SATDATA as a complement to HF voice communications.
- Provides for oceanic and domestic broadband IPS based safety critical data link operations.
- Supports safety critical, safety and regularity of flight operations.

New Capabilities:

- Use of SATCOM voice for all types of ATS communications (routine and emergency/urgency communications).
- Provide high-speed IP based broadband networks.
- Improved security
- Lower cost than the traditional circuit switched services (Classic Aero).

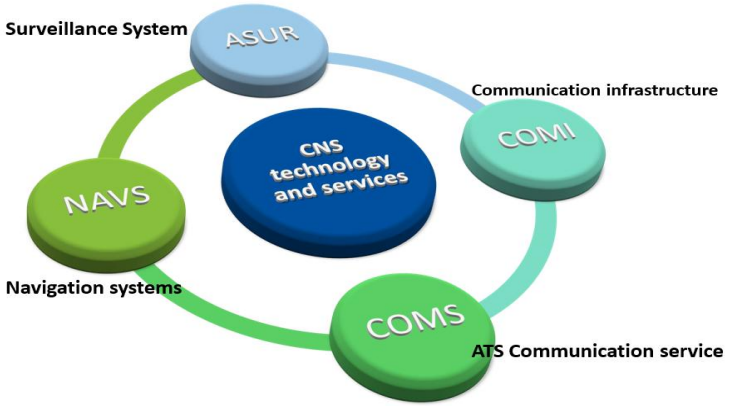
Description: SATCOM System is a broadband, IP based communication system that provides voice and high-speed data communications between the aircraft and the air-traffic controller.
Two constellations are expected to provide this service (INMARSAT and Iridium).
SATCOM Class B (SB-S): SwiftBroadband is available over the Inmarsat 4 satellite constellation, providing near global coverage. SwiftBroadband includes SB-S avionics, the satellite modem that accesses the service, and the aircraft antenna capable of receiving SwiftBroadband and related equipment such as diplexer, LNA, HPA and cabling.
SATCOM Class B (Certus)The Iridium NEXT (Certus) Satellite Network, with its constellation of 66 Low Earth Orbit (LEO) satellites, is a global mobile satellite communication network, with coverage of the entire Earth, including polar regions, offering ATC voice and data service.
This evolution will support enhanced civil-military cooperation and coordination functions, if interoperability and military information security aspects are considered.

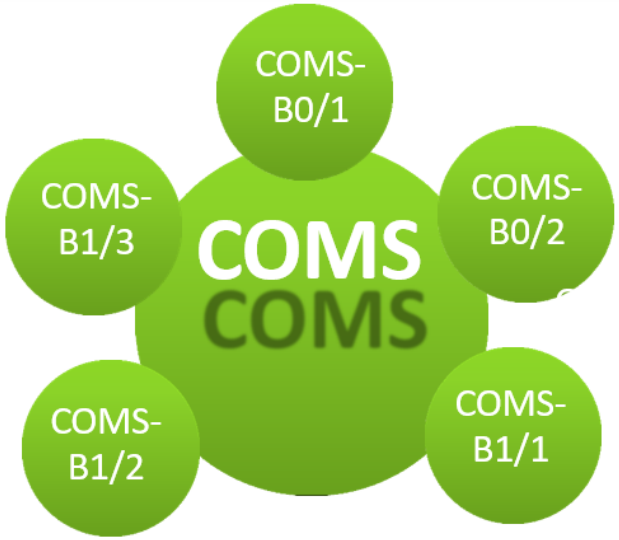
Maturity Level: Ready for implementation
Human Factor Consideration
Planning Layers: Tactical during ops
Operations: Departure, En-route and Arrival
Dependencies and relations: There are currently no dependencies.

4

COMS ASBU ELEMENTS

COMS	ATS Communication service	Technology





COMS-B0/1 CPDLC (FANS 1/A & ATN B1) for domestic and procedural airspace Technology

Main Purpose - Supports :

- reduction of voice channel congestion and increase of capacity in domestic airspace,
- improvement of communication and surveillance in airspace where procedural separation is being applied.

New Capabilities: As a complement to voice communications, controller–pilot data link communications (CPDLC) provides the controller and the pilot with the ability to communicate through exchange of data link messages.

Description: Depending on the specific implementations, other advantages associated with CPDLC include:
1. in certain airspace, direct controller-pilot communications (DCPC) where it was not previously available;
2. allowing the flight crew to print messages;
3. allowing messages to be stored and reviewed as needed;
4. reducing flight crew-input errors by allowing the loading of information from specific uplink messages, such as route clearances or frequency change instructions, into other aircraft systems, such as the FMS or radios;
5. allowing the flight crew to request complex route clearances, which the controller can respond to without having to manually enter a long string of coordinates;
6. reducing flight crew workload by supporting automatically transmitted reports when a specific event occurs, such as crossing a waypoint and the loading of clearance information directly into the flight management system; and
7. reducing controller workload by providing automatic flight plan updates when specific downlink messages (and responses to some uplink messages) are received.

COMS-B0/1 CPDLC (FANS 1/A & ATN B1) for domestic and procedural airspace Technology

For domestic airspaces, ATN B1 CPDLC services provide management of the ATC data link and voice communications, check of ATC microphone stuck and exchange of a limited set of ATC clearances and requests. The vast majority of ATN B1 aircraft do not support any automatic integration of CPDLC instructions into the aircraft Flight Management System.
For procedural airspaces, FANS 1/A CPDLC services provide management of the ATC data link and voice communications, exchange of an extensive set of ATC clearance and requests, reporting of aircraft derived information (including Position Reporting). The vast majority of FANS 1/A aircraft support automatic integration of CPDLC instructions into the aircraft Flight Management System (even though implementations are not harmonized across the flight due to lack of standardization).

Maturity Level: Ready for implementation

Human Factor Human Factor Considerations:

1. Does it imply a change in task by a user or affected others? **Yes**
2. Does it imply processing of new information by the user? **Yes**
3. Does it imply the use of new equipment? **Yes**
4. Does it imply a change to levels of automation? **Yes**

Planning Layers: Tactical during ops
Operations: En-route

Dependencies and relations:

Type of Dependencies	ASBU Element
Relation-technology option	COMI-B0/1 - Aircraft Communication Addressing and Reporting System (ACARS)
Relation-technology	COMI-B0/2 - Aeronautical Telecommunication Network/Open System Interconnection (ATN/OS)

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COMS-B0/2 ADS-C (FANS 1/A) for procedural airspace Technology

Main Purpose: Supports improvement of surveillance in airspace where procedural separation is being applied.

New Capabilities: ADS-C (FANS 1/A) provides aircraft position and projected route information (i.e. next two waypoints ahead of aircraft).

Description: The ADS-C capability provides automatically, without pilot intervention, an ATS unit with information concerning the aircraft position and projected pro le for the flight at time intervals, events or on demand dictated by the ground needs.

Maturity Level: Ready for implementation

Human Factor Considerations:
1. Does it imply a change in task by a user or affected others? **Yes**
2. Does it imply processing of new information by the user? **Yes**
3. Does it imply the use of new equipment? **Yes**
4. Does it imply a change to levels of automation? **Yes**

Planning Layers: Tactical during ops
Operations: En-route

Dependencies and Relations:

Type of Dependencies	ASBU Element
Relation-technology option	COMI-B0/1 - Aircraft Communication Addressing and Reporting System (ACARS)

COMS-B1/1 RCP 240 approved CPDLC (FANS 1A & 1/A+) Technology

Main Purpose - Supports: reduction of voice channel congestion and increased ATS capacity, introduction of new performance-based procedural and ATS surveillance separation minima.

New Capabilities: FANS 1A & 1/A+ CPDLC systems (along with associated air-ground network and physical layers) are demonstrated compliant with RCP240.

Description: RCP240 authorized CPDLC (FANS 1A & 1/A+) provides the controller with intervention capability, and when used in conjunction with other enablers (e.g. ADS-C and navigation capabilities), allows reduced separation minima and thus increased capacity. PBCS also enhances airspace access for State aircraft as it offers opportunities for application of performance-equivalence.
Maturity Level: Ready for implementation
Human Factor Considerations:
1. Does it imply a change in task by a user or affected others? **Yes**
2. Does it imply processing of new information by the user? **Yes**
3. Does it imply the use of new equipment? **Yes**
4. Does it imply a change to levels of automation? **Yes**
Maturity Level: Ready for implementation

Human Factor Consideration

Planning Layers: Tactical Pre ops/Tactical During ops

Operations: Departure and En-route

Dependencies and relations:

Type of Dependencies	ASBU Element
Evolution	COMS-B0/1 - CPDLC (FANS 1/A & ATN B1) for domestic and procedural airspace

COMS-B1/2	RSP180 approved ADS-C (FANS 1A & 1/A+)	Technology

Main Purpose: Supports introduction of: New performance-based reduced procedural separation minima increased ATS capacity.
New Capabilities: FANS 1A & 1/A+ ADS-C systems (along with associated air-ground network and physical layers) are demonstrated compliant with RSP180.
Description:
ADS-C (FANS 1/A) RSP180 authorized provides separation assurance, and when used in conjunction with other enablers (e.g. CPDLC and navigation capabilities), allows reduced separation minima and thus increased capacity.
PBCS also enhances airspace access for State aircraft as it offers opportunities for application of performance-equivalence.
Maturity Level: Ready for implementation
Human Factor Considerations:
1. Does it imply a change in task by a user or affected others? **Yes**
2. Does it imply processing of new information by the user? **Yes**
3. Does it imply the use of new equipment? **Yes**
4. Does it imply a change to levels of automation? **Yes**

Planning Layers: Tactical during ops
Operations: En-route
Dependencies and relations:

Type of Dependencies	ASBU Element
Evolution	COMS-B0/2 - ADS-C (FANS 1/A) for procedural airspace

COMS-B2/1	Advanced CPDLC (Baseline 2)	Technology

Main Purpose: Provision of new data-link functionalities and Improved CPDLC performance for Air Traffic Services (ATS).

New Capabilities: New generation of CPDLC application, named Baseline 2, designed to:

- Improve CPDLC and ADS-C functionalities to support data-link services (legacy and advanced/future) in all airspaces and operational environments,
- Support advanced data-link services (e.g 4D trajectory exchange).

Description:
Baseline 2 data link capabilities (CPDLC and ADS-C) support provision of data communications in all operational environments e.g., continental, oceanic, remote and surface in support of provision of air traffic control services.
Baseline 2 CPDLC has been designed to be independent of the underlying technologies.
PBCS also enhances airspace access for State aircraft as it offers opportunities for application of performance-equivalence.

Maturity Level: Ready for implementation
Human Factor Considerations:
1. Does it imply a change in task by a user or affected others? **Yes**
2. Does it imply processing of new information by the user? **Yes**
3. Does it imply the use of new equipment? **Yes**
4. Does it imply a change to levels of automation? **Yes**

Planning Layers: Tactical Pre ops and Tactical During ops
Operations: Taxi-in, Departure, En-route, Arrival, Taxi-in
Dependencies and relations

Type of Dependencies	ASBU Element
Evolution	COMS-B0/1 - CPDLC (FANS 1/A & ATN B1) for domestic and procedural airspace
Evolution	COMS-B1/1 - RCP 240 approved CPDLC (FANS 1A & 1/A+)
Relation-technology need	COMI-B0/2 - Aeronautical Telecommunication Network/Open System Interconnection (ATN/OSI)
Relation-benefit	COMI-B4/1 - Air-Ground ATN/IPS

COMS-B2/2	Advanced ADS-C (Baseline 2)	Technology

Main Purpose: Provision of new data-link functionalities and performance to support Air Traf c Services (ATS) and the extension of data link communications use in support of including trajectory-based operations, in particular with ADS-C Extended Project Pro le (i.e. predicted route ahead of the aircraft, up to 128 waypoints with their predicted level, speed and time).

New Capabilities: New generation of ADS-C applications, named Baseline 2, designed to:

- support data link services (legacy and advanced/future) in all airspaces and operational environments;
- new data link services (e.g.4D trajectory exchange).

Description:

- Baseline 2 data link capabilities (CPDLC and ADS-C) support provision of data communications in all operational environments e.g., continental, oceanic, remote and surface in support of provision of air traffic control services.
- Baseline 2 ADS-C has been designed to be independent of the underlying technologies.
- PBCS also enhances airspace access for State aircraft as it offers opportunities for application of performance-equivalence.

Maturity Level: Ready for implementation

Human Factor Considerations:

1. Does it imply a change in task by a user or affected others? **Yes**
2. 2. Does it imply processing of new information by the user? **Yes**
3. 3. Does it imply the use of new equipment? **Yes**
4. 4. Does it imply a change to levels of automation? **Yes**

Planning Layers: Tactical Pre ops and Tactical During ops

Operations: Departure, En-route, Arrival

Dependencies and relations:

Type of Dependencies	ASBU Element
Evolution	COMS-B1/2 - RSP180 approved ADS-C (FANS 1A & 1/A+)
Relation-technology need	COMI-B0/2 - Aeronautical Telecommunication Network/Open System Interconnection (ATN/OSI)
Relation-benefit	COMI-B4/1 - Air-Ground ATN/IPS

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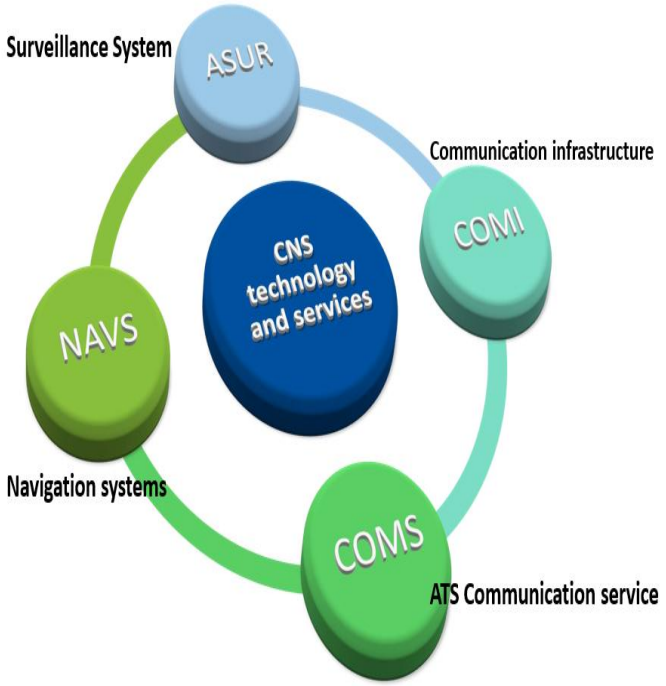
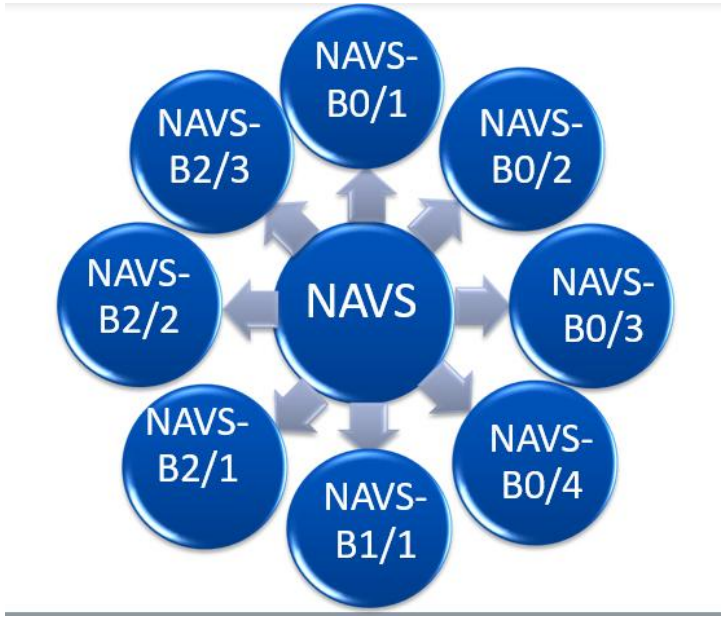
NAVS ASBU ELEMENTS

NAVS	Navigation systems	Technology





NAVS-B0/1 Ground Based Augmentation Systems (GBAS) Technology

Main Purpose: Support Precision Approach and landing operations at a specific airport (one system may support all runway ends). As an option, may support arrival and departure phases of flight.

New Capabilities: Category I performance using GBAS Approach Service Type C (GAST-C). As an option, PBN in terminal area (RNAV 1 and RNP 1 operations) can be supported using GBAS positioning service.

Description: This element introduces improved accuracy, integrity and availability through a local airport based differential satellite navigation and monitoring system. A local network of reference receivers is deployed at or near an airport. Observations from these reference receivers are used to compute corrections for each satellite as well as to monitor for system integrity. The information is broadcast to users via a VHF Data Broadcast link (operating in the 108 to 118 MHz band).

Maturity Level: Ready for implementation
Human Factor Consideration
Planning Layers: Tactical during ops
Operations: Departure and Arrival
Dependencies and relations: There are currently no dependencies.

NAVS-B0/2 Satellite Based Augmentation Systems (SBAS) Technology

Main Purpose: Support PBN in all phases of flight with an increased accuracy, integrity and availability compared to ABAS. Increases accuracy and integrity for the vertical guidance.

New Capabilities: New Capabilities Support all PBN navigation specifications, with a deployment emphasis over RNP APCH down to LPV or LP minima at 250 ft (APV I performance) or 200 ft /550 m (Category I performance).

Description:
This element introduces improvements in the availability, accuracy and integrity of satellite navigation through a wide area differential satellite navigation position and integrity monitoring system. A network of ground reference systems is deployed in a region and connected via a data-network. Observations from the reference systems are used to monitor satellite signals and produce correction and integrity information which is then broadcast over a geostationary satellite link to aircraft. The LPV service volume is mainly determined by the distribution of the monitoring network, depending on the implementation, a wider service volume may be achieved supporting RNP 0.3 and RNP 0.1 performance.

Maturity Level: Ready for implementation
Human Factor Consideration
Planning Layers: Tactical during ops
Operations: Departure, En-route and Arrival
Dependencies and relations: There are currently no dependencies.

NAVS-B0/3 Aircraft Based Augmentation Systems (ABAS) Technology

Main Purpose: Support non-precision (LNAV) and vertically guided (LNAV/VNAV) approaches with BaroVNAV and other terminal and enroute navigations.

New Capabilities:
ABAS supports all PBN navigation specifications with the exception of RNP APCH down to LPV/LP minima. Specific ABAS configurations are required to support RNP AR APCH.

Description:
This element supports non-precision and vertically guided approaches using GNSS lateral navigation and barometric vertical guidance.

Maturity Level: Ready for implementation
Human Factor Consideration
Planning Layers: Tactical during ops
Operations: Departure, En-route and Arrival
Dependencies and relations: There are currently no dependencies.

NAVS-B0/4 Navigation Minimal Operating Networks (Nav. MON) Technology

Main Purpose:
To adjust conventional navaids networks through the increased deployment of satellite based navigation systems and procedures to ensure the necessary levels of resilience for navigation. To provide a minimum level of capabilities to accommodate State aircraft operations where there is a mismatch in terms of aircraft equipage. To make a more efficient use of the frequency spectrum

New Capabilities:
Provision of a navigation backup.

Description:
This element allows the rationalization of the ground based conventional infrastructure through the definition of minimal networks of ground navaids. Consultations and agreements from airspace users and aircraft operators are required to de ne this element.

The MON should be revisited with the introduction of new navigation capabilities.

Maturity Level: Ready for implementation
Human Factor Consideration
Planning Layers: Tactical during ops
Operations: Departure, En-route and Arrival
Dependencies and relations: There are currently no dependencies.

NAVS-B1/1	Extended GBAS	Technology

Main Purpose: To support precision approach and landing operations at a specific airport (one system may support all runway ends). As an option, may support arrival and departure phases of flight.

New Capabilities:

- CAT II operations utilizing GBAS Approach Service Type C (GAST C) in conjunction with enhanced ionospheric monitoring and airplane augmentations.
- Category II/III operations supported by GBAS Approach Service Type D (GAST D).
- Enhanced VHF Data Broadcast (VDB) airborne equipment performance to support interoperability of VDB, ILS and VOR in the 108 - 118 MHz band.

Description: This element introduces improved accuracy, integrity and availability through a local airport based differential satellite navigation and monitoring system. A local network of reference receivers is deployed at or near an airport. Observations from these reference receivers are used to compute corrections for each satellite as well as to monitor for system integrity. The information is broadcast to users via a VHF Data Broadcast link (operating in the 108 to 118 MHz band). This element extends the capability of Block 0 by adding improved ionospheric error monitoring and mitigation as well as enhanced VDB receiver performance to support interoperability and coexistence of ILS, VOR and VDB at any airport.

Maturity Level: Ready for implementation
Human Factor Consideration
Planning Layers: Tactical during ops
Operations: Departure and Arrival
Dependencies and relations: There are currently no dependencies.

NAVS-B2/2	Dual Frequency Multi Constellation (DF MC) SBAS	Technology

Main Purpose:
To increase availability and expand coverage. To reduce cost through the reduction of the need for ground stations.
New Capabilities:
More robust and wider area landing services, including Cat I autoland, possibly Cat II (R&D on-going).
Description:
This module builds upon the basic SBAS systems introduced within Block 0.
New core constellations and signals: (e.g. Beidou, Galileo) or dual frequencies such as GPS, GLONASS will enhance satellite based navigation services through SBAS.
DF MC SBAS provide dual frequency and multi constellation additional navigation signals.

Maturity Level: Ready for implementation
Human Factor Consideration
Planning Layers: Tactical during ops
Operations: Departure, En-route and Arrival
Dependencies and relations:

Type of Dependencies	ASBU Element
Evolution	NAVS-B0/2- Satellite Based Augmentation Systems (SBAS)

NAVS-B2/3	Dual Frequency Multi Constellation (DF MC) ABAS - 2D	Technology

Main Purpose: More robust navigation services (in particular versus loss of a single frequency, or of a single constellation).

New Capabilities: ABAS algorithms use dual frequency and multi constellation additional signals. Only horizontal (2D) enhanced ABAS navigation services are available.

Description: This element builds upon the basic ABAS systems introduced within Block 0.
New core constellations and signals: (e.g. Beidou, Galileo) or dual frequencies such as GPS, GLONASS will enhance satellite based navigation services through ABAS.
DFMC ABAS will use additional navigation signals and new integrity algorithmes (A RAIM).

Maturity Level: Ready for implementation

Human Factor Consideration

Planning Layers: Tactical during ops

Operations: Departure, En-route and Arrival

Dependencies and relations: .

Type of Dependencies	ASBU Element
Evolution	NAVS-B0/3- Aircraft Based Augmentation Systems (ABAS)

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Thank You

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