Communications, Navigation, Surveillance/ Air Traffic Management (CNS/ATM) Conference 2010

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What is CNS/ATM?

The tremendous growth in air traffic presents increasing challenges for air traffic service providers, air carriers, and the military. Such growth is straining airspace capacity and airport resources. The air traffic system requires significant upgrades to increase system capacity and flight efficiency while continuing to meet flight safety standards. The International Civil Aviation Organization (ICAO), Federal Aviation Administration (FAA), and other civil aviation authorities (CAA) plan to implement a new air traffic architecture to meet this need. This new architecture takes advantage of emerging technologies in communication, navigation, and surveillance to improve air traffic management.

Dynamic routing gives operators the freedom to choose their own routes, speeds, and altitudes in real-time, thus providing Visual Flight Rules (VFR) flexibility with Instrument Flight Rules (IFR) protection and separation and a shift from Air Traffic Control (ATC) to Air Traffic Management (ATM). The civil aviation community refers to these changes as Communication, Navigation, Surveillance/Air Traffic Management (CNS/ATM). The United States Department of Defense (DoD) has established the CNS/ATM program to modernize its aircraft.

The ability to reduce aircraft separation and implement other new ATM procedures while maintaining or improving safety standards is enabled by the use of new technology. The most critical technology elements of the new CNS/ATM environment are satellite-based navigation, increased use of data links rather than voice for pilot/controller communication in oceanic/remote airspace as well as en route and terminal environments, and improved surveillance that enhances both ground and cockpit situational awareness. If aircraft are not equipped with the appropriate new technologies, they may not be able to operate in airspaces where new separation standards and ATM procedures are implemented by civil aviation authorities, and may therefore be excluded from those airspaces. For DoD aircraft to operate in this new environment, significant modifications to existing aircraft must be accomplished. The CNS/ATM group of technologies provides the means to achieve the operational capabilities required thus enabling unrestricted global operations.
THE 853 ELSG/NT TEAM

- Participates actively in civil aviation forums, influencing implementation timelines and defining alternate methods to meet technical performance
- Maintains performance matrices based on civil airspace access requirements
- Assists United States Air Force (USAF) Major Commands (MAJCOMs) in determining the operational impacts of CNS/ATM noncompliance
- Converts operational requirements into CNS/ATM technical performance requirements
- Meets with avionics vendors to understand their current product line and to express military needs in terms of future requirements
- In conjunction with platform SPOs, develops candidate system and technical architectures to comply with international standards
- Develops acquisition strategies revolving around maximum use of commercial off the shelf (COTS) and non-developmental items (NDI) to lower acquisition costs
- Issues Indefinite Delivery/Indefinite Quantity (ID/IQ) contracts to support CNS/ATM avionics acquisition. Integration and logistics support from vendors is also under these contracts
- Performs CNS/ATM performance assessments of platforms when requested by platform SPOs
- Prepares a Letter of Compliance (LOC) documenting platform CNS/ATM performance
- Audit and certify AF navigation data chain
- Shares information with the aviation community to foster clear intent and understanding for the mutual benefit of industry and AF organizations
ENGINEERING SUPPORT

Team of Communications, Navigation, and Surveillance engineers assist Platform Program Offices to perform CNS/ATM upgrades
- Expert engineers in all facets of CNS/ATM
- Central repository of lessons learned
- CNS/ATM Performance Matrices gather civilian requirements into one document that may be used as part of a contractual agreement

iGATM (https://igatm.hanscom.af.mil)

Currently re-building documentation library around MS SharePoint. Initially available only to those on AFMC bases.
A web site providing everything Air Force or other interested personnel need to know about CNS/ATM:
- On-line catalog for purchasing CNS/ATM equipment
- Worldwide CNS/ATM Requirements
- Generic CNS/ATM Performance Matrices
- Key CNS/ATM Documents

CNS/ATM On-line Catalog

A function of the iGATM website that allows the customer to “one-stop shop” for key CNS/ATM products, including TCAS and SATCOM

STRATEGIC PROJECTION OF AIRSPACE REQUIREMENTS AND CERTIFICATIONS (SPARC)

Helps users understand CNS/ATM requirements and the airspace where they apply.
Developed by 853 ELSG/NT, therefore no licenses or fees.
Software and data updates can be downloaded on the web.
Proposal to support the SPARC tool including update and maintenance of the online site have been received and award is expected in the near term.
The RCAT offers significant advantages over testing with a real aircraft or Air Traffic Services Unit (ATSU). It is reconfigurable, i.e., it can currently emulate the avionics suites of multiple aircraft (VC-25A, KC-135). The RCAT’s benefits also include the ability to perform instant software updates, have quick responses and turn around times, and operate on a cost efficient basis (saving money on fuel, air crews, maintenance) when compared to flying a real aircraft.

THE WAY AHEAD

Building on early successes, the RCAT is preparing to expand its platform reconfiguration list to include the latest CNS/ATM platforms (C-5, KC-10, C-130). The RCAT team is also developing a collaborative work program with MITRE CAASD and the FAA with the goal of applying their domain experience in the areas of ATC and ATM to DoD operational issues.

For more information on the RCAT or to schedule a visit/demo/tour, please contact:

Michael W. Bernock, 853 ELSG/NT
781.377.9285, mbernock@mitre.org
CNS/ATM Services (cont’d)

DIRECTED SUPPORT

DESCRIPTION
853 ELSG provides CNS/ATM technical/engineering support, upon the request of platform program organizations.

BENEFITS
Platform programs utilize 853 ELSG expertise in specific areas to further expedite and reduce technical risk for CNS/ATM implementation and airworthiness certification.

SAMPLE ACTIVITIES FROM DIRECTED SUPPORT AGREEMENTS
- Evaluation of voice and data communication security issues
- Support Preliminary Design Review (PDR) and Critical Design Review (CDR) activities
- Technical support for platform related source selection activities
- Support testing and verification processes
- Assess CNS/ATM impact to training simulators
- Provide technical risk reduction through simulation in the RCAT

GETTING STARTED
- Determine areas that require CNS/ATM related technical support
- Define a work plan
- Contact 853 ELSG/NT, 781-377-3090, or DSN 478-3090
- Agree on work plan, funding, etc.
- Document agreement, e.g., Memorandum of Agreement (MOA), coordinated between 853 ELSG and Platform Program Office SPDs
CNS/ATM IMPACT ANALYSIS

Aircrew, supported commander, and Air Operations Center feedback from Operation ENDURING FREEDOM (OEF) and Operation IRAQI FREEDOM (OIF) highlight the importance of meeting international Communications, Navigation, and Surveillance (CNS) requirements. The price of not meeting these requirements is manifested in increased flying time per mission, non-optimal routing and altitudes, and increased cost. More importantly, safety of flight and operational impacts are becoming the price to pay for not equipping to meet mandated CNS requirements.

Senior leadership now realizes, based on this real-world contingency feedback, that not being CNS/ATM compliant no longer simply means being slightly inconvenienced when trying to accomplish the mission. ACC/DO tasked all Air Combat Command (ACC) Wing Commanders to quantify and detail their aircrews' OIF CNS/ATM issues and impacts. This initial data call found that Airborne Warning and Control System (AWACS), B-52, Compass Call, and B-2 aircrews experienced substantive CNS/ATM safety, cost, and airspace impacts. At the 26 Jun 03 CNS/ATM IPT at the Air Staff, AQQ, DXOR and DXOO recommended OIF CNS/ATM mission impacts and safety issues be included in future CNS/ATM briefings to senior general officer conferences.

The Global Access, Navigation, and Safety (GANS) Integrating – Integrated Product Team (I-IPT) directed the establishment of a working IPT in support of our request to conduct an analysis of impacts to USAF Operations based from present and future CNS/ATM requirements. The results of this analysis confirmed that not being properly CNS/ATM equipped will increase costs, negatively affect safety, and can lead to airspace denial. More importantly, the initial modeling and simulation effort showed a single non-capable aircraft can cause a ripple effect on operations that can have a significant impact on overall mission effectiveness.

We need your help! If you have any input to this important mission please contact the 853 ELSG/NT POC below to help us with data collection and monitor the progress of the ongoing effort.

Tell us your “CNS/ATM War Story!”

Contact:
Capt Jill Poeppelmann 853 ELSG/NT
CNS/ATM Impact Analysis Project Officer
Jill.Poeppelman@hanscom.af.mil
Comm: 781-377-9064
DSN: 478-9064
# CNS/ATM Systems

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Requirements are levied by Flight Information Region (FIR). FIRs are organized into ICAO Regions:

- AFI – Africa & Indian Ocean
- ASIA – Asia
- CAR – Caribbean
- CONUS – Continental United States
- EUR – Europe
- MID – Middle East
- NAM – North America
- NAT – North Atlantic
- PAC – Pacific
- SAM – South America
Communications

The current Air Traffic Control (ATC) system relies heavily on voice communications between air traffic controllers and pilots. Voice communications are used to relay instructions and other information, essential to safe and expeditious flight, for coordination of aircraft movement, protection of aircraft separation, advisories, clearances and weather services. As air travel continues to increase, voice communications are approaching saturation during peak traffic periods at many locations, especially in Europe.

CNS/ATM communications center on the transition from voice to data link for many routine and non-time critical communications between controllers and pilots throughout the world. Not only will this transition alleviate voice channel congestion, it will also increase flight safety and efficiency through more effective communications between controllers and pilots. Data link communications reduces the amount of missed, repeated, and misunderstood communications which is essential for the CNS/ATM airspace of the future.

COMMUNICATIONS MANAGEMENT FUNCTION (CMF)

FUNCTIONALITY DESCRIPTION:
The Communication Management Function (CMF) performs two important tasks: it manages access to the various data link sub networks and services available to the aircraft and also hosts various applications related to data link. The data sub networks typically managed by a CMF include Very High Frequency (VHF), Very High Frequency (VHF) Data Link Mode 2 (VDLM2), Satellite Communications (SATCOM) and High Frequency Data Link (HFDL). Applications that may be hosted by the CMF include those related to operational command and control (C2) and also Air Traffic Services (ATS). The CMF routes application data between the aircraft and the ground by converting data between the airborne and the air-ground message structures.

CAPABILITIES REQUIRED:
Management of network access
Message routing
Peripheral interfaces
Message prioritization by type
User policy configuration
Application hosting

CNS/ATM AIRSPACE APPLICABILITY:
- AFI
- ASIA
- CAR
- EUR
- NAM
- NAT
- PAC
- SAM

DOCUMENTATION:
- FAA AC 20-115B
- FAA AC 20-140
- RTCA DO-178B/ED-12B
- ARINC 758 -2
- ARINC 618-6
- ARINC 619-3
- ARINC 620-6
- Boeing ATS SR&O D926T0280
- FANS Operations Manual 6.0
- GATM CRD, USAF 003-97
- MIL-HDBK-514
Communications (cont’d)

VERY HIGH FREQUENCY (VHF) – Voice & Data Link

FUNCTIONALITY DESCRIPTION:
VHF voice communications will continue to be an essential component of aviation for the foreseeable future. The US will retain the existing 25 kHz band separations. Europe is experiencing very high densities and has mandated that 8.33 kHz band separations be adopted. It is essential that voice traffic is reduced as the airspace density increases. There are two VHF data link sub networks, both using the 25 kHz band. The ACARS Network using the ACARS protocol (also known as Plain Old ACARS, or POA) is being replaced by VDL Mode 2 Protocols, using the Aviation Link Control (AVLC) protocol, which provides a 10-fold bandwidth increase over POA. To coexist with the ACARS Network, the AVLC Protocol needs to be mapped to the ACARS Network. This is known as ACARS over AVLC (AOA). These two data link sub networks will exist simultaneously for some time. To aid in moving voice traffic to data link, the Controller Pilot Data Link Communications (CPDLC) application has been developed. It is expected that much of the current voice traffic will be transmitted via CPDLC in the future.

CAPABILITIES REQUIRED:
25 kHz and 8.33 VHF Band Separation
Analog or Digital Interface to CMF for POA Data Link Sub network
D8PSK Modem for AOA Data Link Sub network
Communications Service Provider Contract

HIGH FREQUENCY DATA LINK (HFDL)

FUNCTIONALITY DESCRIPTION:
In oceanic, remote and polar airspace, air traffic voice services are provided via high frequency (HF) radio circuits relayed by a communications service provider. HF voice communications tend to be slow, inefficient and prone to interruption by atmospheric and solar disturbances. In non-polar regions, HF voice services are supplemented by SATCOM voice and data services. SATCOM may eventually become the preferred mode of communication in these regions. The one drawback is that SATCOM tends to have relatively high equipment, installation, and transmission costs. It is hoped that HF Data Link (HFDL) will provide a low cost alternative to SATCOM circuits with equivalent message assurance and integrity. However, HFDL transmits at speeds of 600 to 1800 bps and will result in slower transmissions than SATCOM. Consequently, oceanic, remote and polar communications are evolving from relative slow, inefficient HF voice message contacts, to shorter duration SATCOM data messages, complemented by HFDL and HF voice. HFDL has not been approved for air traffic control communications at this time.

CAPABILITIES REQUIRED:
Polar access
Selection between voice and data link
Auto tuning
Communications Service Provider Contract

CNS/ATM AIRSPACE APPLICABILITY:
- AFI
- ASIA
- CAR
- CONUS
- EUR
- MID
- NAM
- NAT
- PAC
- SAM

DOCUMENTATION:
- RTCA DO-178B/ED-12B
- RTCA DO-186B
- RTCA DO-224B
- RTCA DO-281A
- EUROCAE ED-23C
- ARINC 429-11
- ARINC 750-4
- FAA TSO-C169a
- GATM CRD, USAF 003-97
- MIL-STD-461
- JAA Administrative & Guidance Material

HIGH FREQUENCY DATA LINK (HFDL)

FUNCTIONALITY DESCRIPTION:
In oceanic, remote and polar airspace, air traffic voice services are provided via high frequency (HF) radio circuits relayed by a communications service provider. HF voice communications tend to be slow, inefficient and prone to interruption by atmospheric and solar disturbances. In non-polar regions, HF voice services are supplemented by SATCOM voice and data services. SATCOM may eventually become the preferred mode of communication in these regions. The one drawback is that SATCOM tends to have relatively high equipment, installation, and transmission costs. It is hoped that HF Data Link (HFDL) will provide a low cost alternative to SATCOM circuits with equivalent message assurance and integrity. However, HFDL transmits at speeds of 600 to 1800 bps and will result in slower transmissions than SATCOM. Consequently, oceanic, remote and polar communications are evolving from relative slow, inefficient HF voice message contacts, to shorter duration SATCOM data messages, complemented by HFDL and HF voice. HFDL has not been approved for air traffic control communications at this time.

CAPABILITIES REQUIRED:
Polar access
Selection between voice and data link
Auto tuning
Communications Service Provider Contract

CNS/ATM AIRSPACE APPLICABILITY:
- AFI
- ASIA
- CAR
- CONUS
- EUR
- MID
- NAM
- NAT
- PAC
- SAM

DOCUMENTATION:
- RTCA DO-160B
- RTCA DO-163
- RTCA DO-265
- RTCA DO-277
- ARINC 635-5
- ARINC 753-3
- FAA TSO-C158
- ICAO SARPS Annex 10
- ITU Regulations 2001
- GATM CRD, USAF 003-97
- MIL-STD-704D

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Satellite Communications (SATCOM) – Voice and Data Link

FUNCTIONALITY DESCRIPTION:
SATCOM provides highly reliable beyond line of sight (BLOS) network connectivity for aircraft. This allows flight crews to communicate directly with both C2 and air traffic control in oceanic and remote areas via voice or data link. Aeronautical SATCOM provides digitized voice and data communication services using a satellite network that provides worldwide coverage between +78 and -72 degrees latitude. It has proven both timely and reliable. INMARSAT SATCOM was approved for use in air traffic control operations in the early 1990s. It is expected that the Iridium SATCOM network will be approved for the same in the near future. Use of SATCOM for routine and non-time critical operations is an essential element in the transition to the CNS/ATM airspace of the future.

CAPABILITIES REQUIRED:
Continuous network access
Timely transmissions
Integrity and assurance
Communications Service Provider Contract

CNS/ATM AIRSPACE APPLICABILITY:
- AFI
- ASIA
- CAR
- NAT
- PAC
- SAM

DOCUMENTATION:
- FAA AC 20-140
- FAA AC 20-150
- FAA TSO-C132
- FAA TSO-C159
- RTCA DO-210D
- RTCA DO-215A
- RTCA DO-262A
- RTCA DO-178B/ED-12B
- GATM CRD, USAF 003-97
- MIL-HDBK-514
FANS-1/A DATA LINK APPLICATIONS

Automatic Dependent Surveillance – Contract, Controller Pilot Data Link Communications, and Air Traffic Service (ATS) Facilities Notification are three software applications essential for FANS 1/A operations. These applications provide direct connectivity between the aircraft and air traffic control for communication and flight following. FANS 1/A operations began in 1995 in oceanic and remote airspace around the world and are available to roughly 40% of the traffic traversing busy oceanic regions. SATCOM data link is also required. FANS 1/A operational benefits include reduced reliance on voice, more direct routing, ability to change flight plan en route and more.

ATS FACILITIES NOTIFICATION (AFN)

FUNCTIONALITY DESCRIPTION:
ATS Facilities Notification (AFN) provides for the initiation of FANS-1/A data exchange between a pilot and controller via data link. AFN is initiated by the pilot prior to entering FANS 1/A airspace and is essentially an introduction between the aircraft and the Air Traffic Services (ATS) facility. Once a successful AFN has occurred each party has the necessary information for utilization of the Automatic Dependant Surveillance – Contract (ADS-C) and Controller Pilot Data Link Communications (CPDLC) applications. AFN is also used during handoffs between ATS facilities to help reduce the workload on the flight crews.

CAPABILITIES REQUIRED:
Specific message header formatting
ICAO codes/conversion
Message set
CRC
Time stamp

CNS/ATM AIRSPACE APPLICABILITY:
- AFI
- ASIA
- CAR
- EUR
- NAM
- NAT
- PAC
- SAM

DOCUMENTATION:
- FAA AC 20-115B
- FAA AC 20-140
- FAA AC 25.1309-1A
- FAA AC 27-1B
- FAA AC 29-2C
- RTCA DO-258A/ED-100A
- RTCA DO-178B/ED-12B
- ARINC 622-4
- ARINC 618-6
- ARINC 619-3
- ARINC 620-6
- Boeing ATS SR&O D926T0280
- GATM CRD, USAF 003-97
- MIL-HDBK-514
AUTOMATIC DEPENDENT SURVEILLANCE – CONTRACT (ADS-C)

FUNCTIONALITY DESCRIPTION:
Automatic Dependent Surveillance (ADS) provides for the automatic exchange of aircraft position, intent, and flight data by data link from the aircraft to the Air Traffic Services (ATS) facility without pilot interaction. The type of ADS included in FANS-1/A airspace is ADS-C. ADS-C consists of various contracts between the aircraft and the ATS facility, all initiated by the controller. The contracts can be either demand (send the requested data now), periodic (send it every x minutes), or event driven (send it when an altitude, waypoint, vertical speed, or cross-track error threshold is exceeded). The aircraft can support contracts with up to 5 ATS facilities (or 4 facilities and one flight operations connection). Currently the operational environment for ADS-C is FANS-1/A airspace.

CAPABILITIES REQUIRED:
- AFN
- Specific message header formatting
- ICAO codes/conversion
- Message set
- CRC
- Time stamp

CNS/ATM AIRSPACE APPLICABILITY:
- AFI
- ASIA
- CAR
- EUR
- NAM
- NAT
- PAC
- SAM

DOCUMENTATION:
- FAA AC 20-140
- RTCA DO-258A/ED-100A
- RTCA DO-178B/ED-12B
- ARINC 622-4
- Boeing ATS SR&O D926T0280
- GATM CRD, USAF 003-97
- MIL-HDBK-514

CONTROLLER PILOT DATA LINK COMMUNICATIONS (CPDLC)

FUNCTIONALITY DESCRIPTION:
The CPDLC application provides for the exchange of flight planning, clearance, and informational data between a flight crew and air traffic control. This application supplements voice communications and in some areas will likely supersede it in the future. CPDLC contains a series of preformatted messages that can be used by flight crews and pilots to communicate during a flight. CPDLC provides direct connectivity between aircraft and air traffic control in regions where it was unavailable before. CPDLC provides standard message templates for en route message traffic and also offers automatic event reporting (e.g., report reaching altitude).

CAPABILITIES REQUIRED:
- AFN
- Specific message header formatting
- ICAO codes/conversion
- Message set
- CRC
- Time stamp

CNS/ATM AIRSPACE APPLICABILITY:
- AFI
- ASIA
- CAR
- EUR
- NAM
- NAT
- PAC
- SAM

DOCUMENTATION:
- FAA AC 20-140
- RTCA DO-219
- RTCA DO-258A/ED-100A
- RTCA DO-178B/ED-12B
- ARINC 622-4
- Boeing ATS SR&O D926T0280
- GATM CRD, USAF 003-97
- MIL-HDBK-514
NAVIGATION

Worldwide civil navigation requirements continue to evolve as most recently evident in the latest version of the ICAO Performance Based Navigation (PBN), published April 2007 as an update to ICAO Doc. 9613. The PBN establishes a baseline for RNAV and RNP performance standards. RNAV defines total positional accuracy in addition to functional requirements. RNP performance compliance includes total positional accuracy, containment monitoring, integrity monitoring and availability in addition to functional requirements. En route Required Navigation Performance (RNP) categories are RNP-1, RNP-2, RNP-4, Basic Area Navigation (BRNAV) RNAV 5, RNAV routes (Q and T routes), and RNAV 2. Oceanic routes are classified RNAV 10 (RNP-10) and RNP-4 Oceanic. Designations for BRNAV (RNP-5), PRNAV and RNP-10 are being reclassified, resulting from the publication of the PBN, as RNAV 5, RNAV 1 and RNAV 10, respectively. The value (number) in the name is the allowed nautical mile deviation from the assigned route. RNP-x and RNAV-x requires that 95% of the time the total aircraft positional deviation from the designated flight path is less than x nautical miles (NM). When referring to RNP these constraints support Reduced Horizontal Separation Minimums (RHSM) in both lateral and longitudinal dimensions. RNP values that are less than RNP-1 are associated with final approach.

Reduced Vertical Separation Minimum (RVSM) allows 1,000 foot separations (versus 2,000 ft) from Flight Level 290 to FL410, inclusive. RVSM and RHSM together allow aircraft to fly much closer and hence provide more capacity for the airspace.

In addition, upgrades to equipment are necessary in some instances to meet the navigation requirements for operation in the evolving civilian airspace. This list includes Protected Instrument Landing System (P-ILS) / FM Immunity and Precision Landing Systems (PLS). The goal is to provide access to civilian airspace as these navigation requirements are imposed.

Performance Based Navigation (PBN)

PBN is a concept based on the use of Area Navigation (RNAV) systems are not defined by a limited statement of required performance accuracy but require extensive statements of required performance in terms of accuracy, integrity, continuity and availability. The defined performance includes descriptions of how this capability is to be achieved in terms of aircraft and crew requirements. The general capabilities are defined in International Civil Aviation Organization (ICAO) Doc 9613, Performance Based Navigation Manual Implementation Guidance for National Airspace System (NAS) through Federal Aviation Administration Advisory Circulars.
**Performance Based Navigation Terms**

Area Navigation (RNAV) systems are:
- Capable of enabling aircraft operation on any desired flight path within the coverage of space or terrestrial navigation aids or within the limits of the capability of self-contained aids, or a combination of these.
- Not required: performance monitoring and alerting within the aircraft navigation system

RNAV routes are:
- Routes defined by obstacle clearance requirements, traffic density, configuration and ATS intervention
- Terminal, en-route, SIDs and STARs

RNAV operational requirements are:
- Defined by flight plan designation
- Minimum equipment list (MEL)
- Flight crew training

RNAV-(x), the accuracy value (x) represents the navigational system accuracy or minimum airspace/route performance requirement

Required Navigation Performance (RNP) compliant systems are:
- RNAV systems plus:
  - Required to incorporate containment, integrity, continuity and availability requirements
  - Required to implement performance monitoring and alerting within the aircraft navigation system
  - Required compliance with path following procedures (e.g. leg types)

RNP airspace/routes:
- Applicable to all flight phases (includes approach)
- Selectively inclusive of vertical navigation requirements
- May require specific communications and surveillance capabilities, e.g. RNP-4 requires FANS 1/A communications for Oceanic phase for 30/30 separation

RNP operational requirements:
- Same as RNAV plus
- Requires ATC notification when/if non-compliance occurs

RNP-(x), the accuracy value entered represents the navigational system accuracy or minimum airspace/route performance requirement
Navigation

**RNP - 10 (RNAV 10)**

DOCUMENTATION:

Requirements:
- FAA Order 8400.12A, "Required Navigation Performance 10 (RNP-10) operational approval."

Reference:
- FAA AC 20-130A
- FAA Notice 8110.60
- RTCA DO-236B
- Required Navigation Performance (RNP) Compliance Methodology, MITRE Corporation, September 1999
- FAA Strategic Plan for Oceanic Airspace Enhance. and Separation Reduc., page 34, para. 10, Sep 1998

**FUNCTIONALITY DESCRIPTION:**
RNP-10 requires that an aircraft be equipped to ensure it stays within 10 NM of its assigned position 95% of the time. This requirement is applied to Oceanic areas.

**CAPABILITY REQUIRED:**
- Requires an aircraft be within 10 NM of its assigned position (both lateral and longitudinal) 95% of time.
- Dual Navigation system recommended to achieve reliability, availability, and integrity.
- Dual INS or IRUs
- GPS with RAIM and FDE approved for primary means of navigation.

**AIRSPACE APPLICABILITY:**
- Northern Pacific (NOPAC) Routes, Apr 98, FL 310 - 390
- Central East PAC Routes, Feb 2000, FL 290 – 390
- Central PAC, Dec 1998, FL 310 – 390

RNAV and RNP accuracy values are based on Total System Error (TSE). The TSE is the root sum square (rss) of the Path Estimation Error (PEE), the Path Definition Error (PDE) and the Flight Technical or Path Steering Error (FTE/PSE).
**Navigation (cont’d)**

**BRNAV (RNP-5/RNAV 5)**

**FUNCTIONALITY DESCRIPTION:**

It is a requirement that an aircraft be equipped to ensure it stays within 5 NM of its cleared position 95% of the time. BRNAV allows most existing aircraft equipage and uses the current navigation infrastructure. (Current en route navigational aids). Only BRNAV equipped and certified aircraft may fly IFR on the ATS Routes of the Flight Information Regions (FIR), Upper Information Regions (UIR), and/or designated Standard Instrument Departures (SID) and Standard Terminal Arrival Routes (STAR) in and out of Terminal Management Areas identified in the European Regional supplement (ICAO Doc 7030/4).

**CAPABILITY REQUIRED:**
- Requires an aircraft be within 5 NM of its cleared position 95% of time.
- Area navigation capability required (flight management system/mission computer)

**AIRSPACE APPLICABILITY:**
- Includes all ECAC States and others, altitudes dictated by states

**DOCUMENTATION:**
- FAA AC 90 – 96A
- JAA AMJ-20X2, 28/07/98
- German AIC IFR 5/96, AIC IFR 13 Aug 97
- Eurocontrol Std Doc 003-93
- ICAO Supplemental Procedures - Doc 7030/4

**RNAV 1 (P-RNAV)**

**FUNCTIONALITY DESCRIPTION:**

RNAV 1 (formally P-RNAV) is the aircraft and operator approval requirement that is introduced for RNAV procedures in ECAC Terminal Airspace. Terminal Airspace procedures that require RNAV 1 approval are designed following common principles which ensure that procedure design and execution are fully compatible. Additional to the minimum performance and functional requirements appropriate for Terminal Airspace RNAV operations, RNAV 1 approval includes navigation data integrity requirements (Type 2 Letter of Acceptance) and flight crew procedures. In other words, RNAV 1 allows Terminal Airspace operations that are consistent in the various ECAC States, based on procedures design principles and aircraft capabilities that meet the requirement

The required level of navigation accuracy can be achieved using DME/DME, GPS or VOR/DME. It can also be maintained for short periods using IRS (the length of time that a particular IRS can be used to maintain P-RNAV accuracy without external update is determined at the time of certification).

**CAPABILITY REQUIRED:**
- (Precision)-RNAV defines European RNAV operations which satisfy a required track-keeping accuracy of ±1 NM for at least 95% of the flight time.

**AIRSPACE APPLICABILITY:**
- Aircraft operating on RNAV terminal area procedures in ECAC Terminal Airspace.
- P-RNAV offers the ability to use RNAV functionality in all phases of flight except final approach and missed approach. This allows the routes in the terminal airspace to be defined to best meet the needs of the airport, the air traffic controller and the pilot.

**DOCUMENTATION:**
- TGL-10
- FAA AC 90-96A
- FAA AC 90-100A
- RTCA DO 200A/ED 76
- AC 20-138, AC 20-130, AC 90-45A
- TSO 129a
- MSO 129a
- AC 20-130
**Navigation (cont’d)**

**RNP – 4**

**FUNCTIONALITY DESCRIPTION:**
RNP-4 RNAV requires that an aircraft be equipped to ensure it stays within 1 NM of its cleared position 95% of the time. Further details on this constraint are in the defining documents. RNP-4 will largely be applied to terminal operations including missed approach, though some RNP-4 routes may be defined in Europe.

**CAPABILITY REQUIRED:**
- Requires an aircraft be within 1 NM of its assigned position (centerline) 95% of time.
- FMS functionality required
- ADS-C
- CPDLC
- Navigation database

**AIRSPACE APPLICABILITY:**
- Europe - 2012 +

**DOCUMENTATION:**
- FAA Order 8400.33
- RTCA DO-236B
- RTCA DO-283
- RTCA DO 200A/ED 76
- AC 20-138, AC 20-130, AC 90-45A
- TSO 129a
- MSO 129a
- AC 20-130

**RNP – 4 OCEANIC/REMOTE**

**FUNCTIONALITY DESCRIPTION:**
For RNP - 4 Oceanic and Remote operations, it is required that an aircraft be equipped to ensure it stays within 4 NM of its cleared position 95% of the time. RNP - 4 allows a 30 NM lateral and longitudinal separation between aircraft.

**CAPABILITY REQUIRED:**
- Requires an aircraft be within 4 NM of its assigned position (centerline) 95% of time.
- FMS Functionality Required
- ADS-C
- CPDLC
- Navigation database

**AIRSPACE APPLICABILITY:**
- Pacific (PAC) -- > 2005 test cases

**DOCUMENTATION:**
- FAA Order 8400.33
- RTCA DO-236B
- RTCA DO-283
- RTCA DO 200A/ED 76
- AC 20-138, AC 20-130, AC 90-45A
- TSO 129a
- MSO 129a
- AC 20-130
REDUCED VERTICAL SEPARATION MINIMUM (RVSM)

FUNCTIONALITY DESCRIPTION:
The RVSM enables the reduction of vertical separation to 1,000ft (from the current 2,000ft minimum) from FL290 to FL410, inclusive. This allows aircraft to safely fly more optimum profiles, gain fuel savings and increase airspace capacity. In 1988, the ICAO Review of General Concept of Separation Panel (RGCSP) completed a study on RVSM and concluded that safe implementation of the 1,000-ft separation standard was technically feasible.

AIRSPACE APPLICABILITY:
- NAT -- Jan 2002, FL290 - 410
- PAC -- Oct 2000, FL290-410
- EUR -- Jan 2002, FL290 - 410
- CONUS/Canada South -- Jan 05 DRVSM, FL290 - 410
- SAT -- Jan 2002, FL290 - 410
- WATRS -- Jan 2002, FL290-410
- WPAC/S CH Sea -- Feb 2002, FL290 - 410
- Mid East -- Nov 2003, FL290 - 410
- North Canada – Apr 2002, FL290 - 410

DOCUMENTATION:
- FAA AC 91-RVSM, Appendix G
- Primary AIC’s: AIC Nr 33/00, AIC A 16/01, AC 91-4, AIC A2/01, AIC 5/100, AIC 16/2001
- FAA AIC 80/9096 (Yello 226)
- EUROCAE Documents 9574, 9536, 9572
- Civil Regulatory Documents: FAA FAR Part 91, Annex G

FM IMMUNITY, PROTECTED INSTRUMENT LANDING SYSTEM, AND VHF OMNIDIRECTIONAL RANGE (FMI, P-ILS, VOR)

FUNCTIONALITY DESCRIPTION:
In Europe the FM radio station transmissions have been found to interfere with the Instrument Landing Systems (ILS) localizer signals, VHF Omnidirectional Range (VOR) navigation aids, and VHF voice communications. For this reason, Europe has established a requirement that navigation radios be “FM immune.”

AIRSPACE APPLICABILITY:
- Europe since Jan 2001

DOCUMENTATION:
- UK CAA Airworthiness Notice No. 84
- Ger NfI II 68/94
- Ger NfI 75/96
- ICAO EUR, Doc 006/5, ILS/VOR/FM Compatibility in European Region, Ver 5, Sep 1999, App A-F(Table)

CAPABILITY REQUIRED:
- Two Independent Pressure Altitude Measuring Systems With Digital Display
- One Altitude Reporting Transponder
- Altitude Alert System
- Automatic Altitude Control System (Autopilot)

CAPABILITY REQUIRED:
- ILS receivers in Europe must meet new FM Interference Requirements.
- The VOR and VHF voice receivers must be upgraded or Radio Frequency (RF) filters must be installed.
VERTICAL NAVIGATION (VNAV)

FUNCTIONALITY DESCRIPTION:
Vertical navigation (VNAV) capability enables vertical path guidance to be computed as deviation from a desired ascending or descending path to a specified altitude at a waypoint. Vertical guidance is generally provided as a linear deviation from the desired track defined by a line joining two waypoints with specified altitudes or as a vertical angle from a specified waypoint. VNAV may be enhanced by inclusion of secondary inputs such as optimized climb or descent profiles, vertical acceleration and true airspeed. The desired vertical path may be pilot selectable or may be determined by the VNAV computer by computations based on the altitudes associated with successive waypoints.

A vertical navigation system may be approved for en route, terminal and approach use.

CAPABILITY REQUIRED:
- VNAV capable FMS with temperature compensation
- Baro-altimetry system

DOCUMENTATION:
- RTCA DO-200A
- RTCA DO-201A
- RTCA DO-236B
- FAA AC 20-129
- FAA AC 90-97
- FAA AC 90-100A

AIRSPACE APPLICABILITY:
- NAS and selected CAAs
- Supports LNAV/VNAV approach
- Approved baro-VNAV systems support terminal and en-route operations
**TIME OF ARRIVAL CONTROL (TOAC)**

**FUNCTIONALITY DESCRIPTION:**
The TOAC function provides the temporal or speed control that enables 4 dimensional (4D) navigation to be accomplished. This function supports the spacing and metering associated with air traffic management. Typical of the parameters for time of arrival control are the computation of path length to the time constrained fix, ground speed, time remaining, target speed and speed error. Having determined the time of arrival error, the time of arrival control function computes a target speed for the aircraft. This target speed may be supplied to the flight control system or displayed to the flight crew. The target speed is used to correct arrival time errors at the time constrained fix. The overall time control achieved will depend upon the accuracy of the parameters input or calculated, the control system accuracy, external factors such as winds, and the aircraft performance.

**CAPABILITY REQUIRED:**
- FMS/Mission Computer capable of combining position and airspeed sensor inputs to provide temporal calculations

**DOCUMENTATION:**
- FAA AC 20-138
- RTCA DO-283
- RTCA DO-236B

**AIRSPACE APPLICABILITY:**
- 4D RNAV & 4D RNP RNAV (future, 2015+)
GLOBAL POSITIONING SYSTEM (GPS)

FUNCTIONALITY DESCRIPTION:
A constellation of 30 satellites orbiting 11,000 miles above the earth emits signals to receivers on earth. When receiving signals from at least 4 satellites, a GPS receiver can determine latitude, longitude, altitude and time. The Department of Defense (DoD) also uses GPS for navigation in civil airspace, including non-precision approach operations, and maintains an upgrade path to ensure unique military use of GPS can be exploited.

CAPABILITY REQUIRED FOR IFR OPERATIONS:
- MSO or TSO certified GPS receiver
- RAIM
- FDE

AIRSPACE APPLICABILITY:
- Required for all DoD aircraft 2005 for missions.
- Enroute and terminal when not augmented
- Can support all RNP/RNAV Operations

DOCUMENTATION:
- FAA TSO-129A GPS Supplemental Means Navigation
- FAA Notice 8110.60 GPS Primary Means Oceanic and Remote Navigation
- FAA requirements of TSO-C146 (using GPS augmented by WAAS/LAAS)
- FAA requirements of TSO-C145 (using GPS augmented by WAAS/LAAS)
- OASD C31 Security Policy
- FAA-F-8000-3 A Guide for Approval of GPS Receiver Installation and Operation
- MASPS, RTCA DO-217
- MOPS, DO-229B (WAAS)
- DO-178B (Software)
- MOPS DO-208 (GPS)
- MSO 129a
- MSO 145
**Navigation (cont’d)**

**Differential Global Positioning Systems (DGPS)**

GPS alone does not meet navigation requirements for accuracy, integrity and availability for all operations. DGPS corrects for the GPS satellite position errors, atmospheric delays, and other disturbances in the GPS signals, improving the accuracy and reliability of the users’ position solution. There are currently two forms of augmentation, Satellite Based and Ground Based.

**Satellite Based Augmentation Systems (SBAS)**

**FUNCTIONALITY DESCRIPTION:** (gps.faa.gov)

SBAS is a navigational system representing an enormous leap forward in air navigation. It provides vertically-guided approach capability at thousands of airports and airstrips where this capability had previously not been affordable. It is a core element in transitioning to the satellite-based air traffic control system of the future. SBAS is designed to improve the accuracy and ensure the integrity of positioning and timing information from GPS satellites. The system also provides the necessary guarantees that its signal will be accurate, available, and safe to use at all times. More importantly, SBAS warns the pilot when the satellites are not functioning correctly and should not be used for navigation.

SBAS ground stations take measurements of the GNSS satellites in view, and are able to compute corrections to the GPS signals it is receiving. Using these measurements, information messages are created and sent to one or more Geostationary communication satellites for broadcast to an appropriately equipped aircraft.

SBAS requires an aircraft equipped to be able to receive and decode the signal being broadcast by the geostationary satellites. It also requires a navigation database certified to the “Critical” level per DO-200A/201A in order for the system to compute corrected aircraft position against the expected (database) flight path.

SBAS is being used operationally in the following areas:
1. United States – Wide Area Augmentation System (WAAS)
2. Japan - Multi-functional Satellite Augmentation System (MSAS)
3. Europe - European Geostationary Navigation Overlay Service (EGNOS)

**DOCUMENTATION:**
- TSO-C129
- TSO-C145a
- TSO-C146a
- AC 20-130a
- AC 20-138a
- AC 90-94
- RTCA/DO-229D

**CAPABILITY REQUIRED FOR IFR OPERATIONS:**
- TSO Certified GPS receiver
- DO-200A/201A certified navigation database (Critical level)

**AIRSPACE APPLICABILITY:**

SBAS is not mandated for use, but is an operational enabler for aircraft conducting IFR Category I approaches into airfields not equipped with an Instrument Landing System. It is also an enabler for RNP and RNAV capability on aircraft.
FUNCTIONALITY DESCRIPTION: (gps.faa.gov)
GBAS augments GPS to provide an all-weather approach and landing navigation capability. GBAS provides precision approach service within a nominal 23-mile coverage volume around the airport where the ground system is installed. The ground system broadcasts differential GPS corrections, integrity messages and approach path data via a very high frequency (VHF) radio data link to the aircraft. GBAS meets the high accuracy and availability performance requirements necessary for Category I, II, and III precision approach operations. GBAS is expected to provide improved service over existing Instrument Landing Systems (ILSs) and reduced operating costs.

In addition, a single GBAS ground system can provide precision approach capabilities to all runways at an airport. This reduces the need for costly redundant infrastructure found with ILS. Also GBAS can provide precise positioning information of aircraft that can be used by surface surveillance systems to prevent runway incursions during low visibility conditions. The system also allows for curved and segmented approach paths, not possible using current ILSs, for Category I, II, and III precision approaches.

Aircraft equipage of C/A Code GPS receivers and VHF data radios are required to implement GBAS. Also, onboard aircraft processing is required to provide a differentially corrected position and approach path guidance.

The requirements for Category I approaches have been validated with ICAO and established in civil GBAS installations across the United States and other countries. Currently, the requirements for Category II/III are in the process of ICAO and system validation.

CAPABILITY REQUIRED FOR IFR OPERATIONS:
- TSO Certified GBAS-capable GPS receiver
- TSO Certified VHF receiver

DOCUMENTATION:
- ICAO SARPS Standards and Recommended Practices for the GBAS aircraft element.
- FAA-E-2937A
- RTCA/DO-253C
- RTCA/DO 245
- RTCA/DO-246D
- TSO C162
- TSO C161
- ED-88
- ED-95
- ED-114
- ED-144

AIRSPACE APPLICABILITY:
GBAS is not mandated for use, but is an operational enabler for aircraft conducting IFR Category I/II/III approaches into airfields not equipped with an Instrument Landing System.
Joint Precision Approach and Landing System (JPALS)

**FUNCTIONALITY DESCRIPTION:** JPALS will have two modes of operation, a civil mode similar to GBAS, and a military mode. JPALS’ military mode is a GBAS that augments GPS P(Y) Code to provide an all-weather approach and landing navigation capability in GPS threat environments. JPALS civil mode will meet the majority of the civil GBAS requirements. JPALS will have a System Requirements Document (SRD) that defines the functional and performance requirements for both modes of the system. JPALS is expected to provide a single interoperable solution for all DoD Services and support Civil Reserve Air Fleet operations at DoD airfields.

The ground system military mode broadcasts differential GPS corrections, integrity messages and approach path data via an encrypted ultra high frequency (UHF) radio data link to the aircraft. JPALS initial capability will meet the accuracy and availability performance requirements necessary for Category I precision approach operations.

In addition, a single JPALS ground system can provide precision approach capabilities to all runways at an airport. This reduces the need for costly redundant infrastructure found with ILS. Also JPALS can provide precise positioning information of aircraft that can be used by surface surveillance systems to prevent runway incursions during low visibility conditions. The system also allows for curved and segmented approach paths, not possible using current ILSs for Category I precision approaches.

Aircraft equipage of P(Y) Code GPS receivers and UHF data radios are required to implement JPALS. Also, onboard aircraft processing is required to provide a differentially corrected position and approach path guidance.

**CAPABILITY REQUIRED FOR MILITARY MODE IFR OPERATIONS:**
- Certified GPS receiver per JPALS Aircraft Specification
- UHF Data Link Receiver
- Processing of Differentially Corrected Position and Guidance

**DOCUMENTATION:**
- Inc 2 Land-Based JPALS SRD ~ 2011
- Inc 2 Land-Based JPALS Aircraft Specification (To Be Developed ~ 2014)
- Inc 2 Land-Based JPALS Aircraft Integration Guide (To Be Developed ~ 2014)

**AIRSPACE APPLICABILITY:** JPALS provides a single technology (DGPS) to support all DoD land-based and sea-based precision approach and landing capabilities.

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**JPALS**

- **Joint Interoperable Solution**
- **Satellite Based Augmentation System**/Local Area Augmentation System
- **GBAS/LAAS**
- **SBAS/WAAS**

**JPALS Man-pack Prototype Equipment**
A crucial element of navigation safety is navigation data integrity. Changes in navigation data integrity can have serious flight and mission consequences. 853 ELSG is responsible for certifying that the production and distribution of aeronautical navigation data for the United States Air Force (USAF) is consistent with civil standards.

**Navigation Data Chain**

**FUNCTIONAL DESCRIPTION:**
A data chain is the linked series of people, processes and systems that the navigation data takes from the data originator to the user of the data in the aircraft. The figure to the right is a simplified representation of the current USAF data chain. The data chain includes both the forward path that the data follows as well as the error reporting or feedback paths. Operations on the data by any node in the chain can include format changes, coordinate changes, and transmission. The preparation and distribution of aeronautical navigation data at the wing for specific aircraft is supported by software tools. These tools are procured as part of the Mission Planning System acquisition.

**NAVIGATION DATA SUPPLIER:**
For the DOD/USAF, the National Geospatial Intelligence Agency (NGA) is responsible for collecting navigation data from various sources (e.g., sovereign “states”) and supplying the data in a standard format (DAFIF, the Digital Aeronautical Flight Information File).

**NAVIGATION DATA USERS:**
USAF aircraft platforms’ Mission Planning Systems (MPS) extract a mission-specific subset of the navigation data from DAFIF, transform the data into an aircraft-specific format, and load the transformed data into an aircraft’s navigation database load media.

**CNS/ATM APPLICABILITY:**
- USRNAV
- PRNAV
- RNP-4
- RNP-1
- RNP-0.3

**DOCUMENTATION:**
- FAA AC 20-153
- RTCA/DO-200A
- RTCA/DO-201A
- AFPD 63-13
- AFI 63-1301
Certification Process

853 ELSG CERTIFICATION ROLE AND RESPONSIBILITY:
853 ELSG certifies that the navigation data is prepared and distributed in a manner that is consistent with civil standards. These standards provide confidence that integrity of navigation data is maintained throughout the entire data chain – supplier and user segments, i.e., that the operations on the data (e.g., format changes, coordinate changes, and transmission) do not change the accuracy and resolution of the data. The supplier-to-user data chain segment addressed by 853 ELSG, depicted by the shaded area in Figure 1, includes DAFIF production at NGA, preparation of the aircraft’s navigation data load, and the error reporting chain (currently handled by the Mission Planning System Support organization at Hill AFB). The certification does not address the original data quality/resolution from its sources or the loading of the data onto the aircraft. The loading of the data onto the aircraft is addressed as part of the performance assessment process. ESC issues three types of certification.

CERTIFICATION TYPES:

Type 1 Certification: A Type 1 certification, defined in FAA AC-20-153, is generic in nature. Type 1 certifications are never tied to a particular configuration of aircraft or navigation equipment. Type 1 certification indicates that a particular organization has implemented the required processes and procedures deemed necessary to satisfy the requirements for producing navigation data.

Type 2 Certification: A Type 2 certification, defined in FAA AC-20-153, indicates that a specific set of procedures, using a specific configuration of hardware/software tools, will satisfy the requirements for delivering data for a particular navigation purpose in a specifically configured aircraft. A Type 2 certification is always given to a particular configuration which must be identified.

Tool Certification: In addition to the approvals described in the civil standards, AFI 63-1301 directs 853 ELSG to “certify Air Force Mission Planning Systems navigation data processing will meet CNS/ATM requirements.” This tool certification supports an airworthiness assessment of the mission planning tools and does not, by itself, imply a certification of the data chain.
AUDITS:
853 ELSG certifies the navigation data chain by performing audits. The audits are performed to a degree commensurate with (but not necessarily identical to) established civil requirements. 853 ELSG audits NGA for a Type 1 certification based on data requirements captured in the DAFIF Product Specification 1, as well as RTCA/DO-200A, and FAA AC 20-153. The data chain as a whole is audited for Type 2 certifications based on requirements from the end-user, which are aircraft-specific, as well as RTCA/DO-200A, RTCA/DO-201A and FAA AC 20-153. In the USAF, several organizations work together to implement the data chain. Consequently, multiple audits of different organizations are required for a Type 2 certification. The Tool Audit is a part of the Type 2 audit process.

CERTIFICATION DOCUMENTATION:
853 ELSG issues letters documenting certification: one for a Type 1 certification, one for each Type 2 certification, and one for each Tool certification. The Type 1 Certification Letter states that NGA is a certified supplier of navigation data (i.e., DAFIF). This means that 853 ELSG has determined that NGA has instituted the required processes and quality management controls. The Type 2 certification letter identifies the specific data chain configuration being certified, and identifies which requirements have been certified.

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<thead>
<tr>
<th>Table 1: Certification Process</th>
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<td><strong>Type 1</strong></td>
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<td>Recipient of Certification</td>
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Navigation Safety (NAVSAFETY)

Terrain Awareness and Warning System (TAWS) and Predictive and Reactive Windshear Systems are NAVSAFETY related functions. These functions provide flight crews with situational awareness, alerts and, where applicable, recommended maneuver guidance. These systems are mandated by Air Force direction, since 1996, for passenger and troop carrying aircraft.

TERRAIN AWARENESS WARNING SYSTEM (TAWS)

FUNCTIONALITY DESCRIPTION:
The Terrain Awareness and Warning System (TAWS) supports safe operation by providing three functions: Forward-Looking Terrain-Avoidance (FLTA), Premature Decent Alert (PDA) and Ground Proximity Warning.

CAPABILITY REQUIRED:
- TAWS system with associated user interfaces

AIRSPACE APPLICABILITY:
- USAF Nav Safety Requirement, civil requirement in CONUS

DOCUMENTATION:
- AC 25-23, Airworthiness Criteria for the Installation Approval of TAWS Approved for part 25 aircraft
- RTCA DO-161A, Minimum Performance Standards - Airborne Ground Proximity Warning Equipment
- ARINC 723-1
REACTIVE AND PREDICTIVE WINDSHEAR

FUNCTIONALITY DESCRIPTION:
Windshear is the generic term used to describe rapidly changing horizontal (1 and 3 in the figure) or vertical (2 in the figure) air currents. Windshear detection systems can be classified in two categories:

a) Reactive Systems use various sensor inputs to identify the presence of windshear once the phenomenon is encountered and provides the pilot with timely warning and adequate flight guidance to improve the probability of recovery from the windshear encounter. This system will include both windshear warning and windshear caution alerts. The system provides the crew with flight guidance information to improve the recovery probability once encountering a windshear phenomenon. A reactive system may also integrate or couple an autopilot and/or autothrottle systems of the aircraft with an airborne windshear flight guidance system.

b) Predictive systems are radar-based and provide a pilot with anticipatory information on levels of turbulence in the flight path. The radar processes the characteristics of precipitation returns to determine if windshear is present. Predictive windshear systems are usually capable of windshear detection, weather detection and ground mapping.

CAPABILITY REQUIRED:
- Weather radar with appropriate performance and processing software
- Multifunction display capable of presenting windshear indications

AIRSPACE APPLICABILITY:
- USAF Nav Safety Requirement, civil requirement in CONUS

DOCUMENTATION:
- Reactive
  - FAA TSO-C117a
  - FAA AC 25-12
  - SAE ARP 4102/11
- Predictive
  - RTCA DO-173
  - RTCA DO-220
Surveillance

SURVEILLANCE

The surveillance needs are TCAS II, Mode S Transponder, and ADS-B in the future. The Traffic Alert and Collision Avoidance System (TCAS) II version 7 is a well established capability which is a requirement on troop or passenger carrying aircraft. Mode S is the evolutionary replacement of the Air Traffic Control Radar Beacon System (ATCRBS) transponder and is required in most Western European states. The Mode S transponder is required for TCAS II systems. Mode S supports a number of advanced capabilities including air-ground and air-air data link. Automatic Dependent Surveillance - Broadcast (ADS-B) uses positional information transmitted from the aircraft in lieu of an independent surveillance system (e.g., a radar). The goal is to provide continuing access to civilian airspace as these surveillance/safety requirements are imposed. The ADS-Addressed (ADS-A) is an application of communication and is covered the communications part of this booklet. ADS-A is also referred to as ADS-Contract (ADS-C), or simply as ADS.

TRAFFIC ALERT and COLLISION AVOIDANCE SYSTEM (TCAS)

FUNCTIONALITY DESCRIPTION:
TCAS is an airborne safety system which provides Traffic Advisories (TA) and vertical Resolution Advisories (RA) for collision avoidance. TCAS I provides TAs, while TCAS II provides additional vertical collision avoidance maneuver RAs. Version 7.0 is the accepted system. Correspondingly, ICAO has defined Airborne Collision Avoidance Systems (ACAS) I and II. All TCAS II V 7.0 systems meet the international standards for ACAS II. Variants are available which meet military-specific needs. For example, the Enhanced-TCAS II (E-TCAS) has functionality to support station keeping in air-to-air refueling and MILACAS to support formation flight. It is expected that TCAS II version 7.1 (a software upgrade to version 7.0) will be required in Europe in the next several years.

CAPABILITY REQUIRED:
- TCAS II version 7 / ACAS II System (requires antenna installation)
- Mode S Transponder (version 7 compatible, no change is needed to support version 7.1)
- Stand-Alone Display, EFIS, or Integrated MFD
- Controls and audio alerts

AIRSPACE APPLICABILITY:
- USAF: All USAF troop or passenger carrying aircraft have to be equipped
- USA: The FAA TCAS II requirement is not applicable to DoD aircraft
- Foreign: TCAS II operation in RVSM airspace requires version 7.0 or higher
- Germany: State (military) aircraft 31 March 2006 exemptions have been given when requested

DOCUMENTATION:
- FAA AC 20-151A, Airworthiness and Operational Approval of TCAS and Mode S Transponder
- EUROCONTROL Specimen AIC – TCAS
- TSO-C-119B, TSO-C-11
- ARINC 735
- RTCA DO-185B
AUTOMATIC DEPENDENT SURVEILLANCE - BROADCAST (ADS-B)

FUNCTIONALITY DESCRIPTION:
ADS-B allows pilots and air traffic controllers to see aircraft traffic with more precision than has been possible before. The FAA and EUROCONTROL have identified more than 20 uses of ADS-B to improve safety and provide more efficient use of the airspace.

Each ADS-B equipped aircraft broadcasts its precise position and other data including future intent. This provides anyone with ADS-B receive equipment (airborne or ground based) to develop an accurate depiction of air traffic. ADS-B can provide coverage at low altitudes and on the ground, so that it can be used to monitor traffic on the taxiways and runways of an airport, and in valleys and behind mountains where radar coverage is limited.

ADS-B OUT provides the broadcast of information from the aircraft and ADS-B IN provides the reception of ADS-B information and display of this data to the pilot on a Cockpit Display of Traffic Information (CDTI).

Australia has implemented ADS-B OUT as a radar alternative and the US is planning a nation-wide implementation with mandated equipage in 2020. On Jan 1, 2010 Canada began limited use of ADS-B over the Hudson Bay. Europe is also studying the applicability of ADS-B both IN and OUT.

CAPABILITY REQUIRED:
- DoD preference is 1090ES which is also recognized as the common international link. The Universal Access Transceiver (UAT) is a second US FAA ADS-B link authorized for aircraft that fly below FL 240.
- Position, time, integrity, and potentially future position information from the navigation system and FMS or GPS.
- Mode-S Transponder for 1090ES
- Cockpit Display of Traffic Information (CDTI) function to see the data in the aircraft (for ADS-B IN)

AIRSPACE APPLICABILITY:
- Alaska – FAA has fielded “Capstone” which includes air and ground UAT infrastructure with 1090ES infrastructure being installed.
- US Airspace – FAA has fielded infrastructure from New Jersey to Florida with UAT and 1090ES. Plans to further expand the network over the entire US. The Notice of Proposed Rule Making (NPRM) from the FAA identified a planned mandated equipage by 2020.
- Canada – The Hudson Bay area is equipped with ADS-B ground stations. Access to FL350 – 400 is reserved for aircraft with approved ADS-B installations. ADS-B requirements will expand East, West and vertically over the rest of the country.
- Netherlands – Low altitude (4000 ft and below) over the North Sea will be restricted to ADS-B aircraft in the next few years.
- Current users including UPS and Embry-Riddle University
- Future plans are being considered in numerous places around the world.

DOCUMENTATION:
- RTCA SC-186, MASPS, DO-242A
- RTCA SC-186, MOPS, DO-260B (1090ES)
- TSC-C166 and TSC-C166A in the near future
**FUNCTIONALITY DESCRIPTION:**
The Mode Select (Mode S) Radar Beacon System is an evolutionary replacement for the Air Traffic Control Radar Beacon System (ATCRBS). It is compatible with ATCRBS and operates on the same internationally allocated frequencies (1090 MHz transmit and 1030 MHz receive). The primary role of the Mode S transponder is to respond to interrogations from a ground sensor or a Traffic Alert and Conflict Avoidance System (TCAS), and to provide airborne data information including identification and altitude.

The FAA has no plans to require Mode S transponders, except as required for TCAS II. However, aircraft equipped with TCAS II must have a Mode S transponder to provide a datalink between the aircraft and the ground sensor and between TCAS II equipped aircraft.

Seven central European countries require Elementary Surveillance (ELS) and four (Germany, France, Switzerland, and UK) have further defined Enhanced Surveillance (EHS for transport-class aircraft) requirements for their airspace for both civilian and military aircraft. The mandated equipage date for military aircraft was 3/31/2009. Specifically, for ELS the transponder must transmit the following data: 24 bit aircraft address, SSR Mode 3/A code, aircraft identification (flight ID), altitude (25 foot increments desired), flight status, data link capability report, common usage GICB capability report, and the ACAS active resolution advisory (if ACAS is installed on the aircraft).

The EHS additionally requires the ability to download information from three additional transponder registers to support advanced ATC applications. This is sometimes referred to as Downlink of Aircraft Parameters (DAP). Transport class aircraft and a few others are expected to have EHS. It is not required of high performance and highly maneuverable aircraft.

Mode S is fully operational in CONUS at over 140 sites. Exemptions for State (including military) aircraft flying in ELS and EHS designated airspace in Europe have been issued and are in effect.

**CAPABILITY REQUIRED:**
- Mode S Level 2 Transponder compliant to ICAO SARPS Annex 10 Vol. 4, Amendment 77.
- DoD Mode S/IFF transponders must be AIMS certified.
- An additional FAA TSO is strongly recommended
- Version 7 upgrades should be included to support TCAS II
- Associated antenna(s) and controls.

**AIRSPACE APPLICABILITY:**
- Europe: State Aircraft (including military)
- ELS and EHS from 3/31/2009
- Germany will not allow Mode 3/A and C operations by the end of 2012
- USA: No expected requirement from the FAA except as required for TCAS II.

**DOCUMENTATION:**
- DO-181D, December, 2009
- ICAO Doc 7030/4 and Annex X volumes III and IV
- ICAO Document 9871
- Ger AIC 23 Jan 03
- EUROCONTROL Specimen AIC, Intro of SSR Mode S
- TSO-C112
- ARINC 718(a) as applicable to military installations
- http://www.eurocontrol.int/msa/
- EUROCONTROL Specimen AIC ICAO 24-bit aircraft address and aircraft identification reporting
- European Aviation Safety Agency (EASA) document AMC20-13
## CNS Capabilities, Airspace Applicability, & Need Dates

<table>
<thead>
<tr>
<th>Capability</th>
<th>Africa-Indian Ocean</th>
<th>Asia</th>
<th>Caribbean</th>
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<th>Middle East</th>
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<tr>
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<td>01/14</td>
<td>80/80</td>
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**Notes:**
- Mandatory worldwide for ATS communications except oceanic and remote
- Effective above FL195. Will cover all flight levels in a few years. Elsewhere use 25 kHz radio.
- Mandatory in all oceanic airspace; an Air Force requirement
- Digitized voice over the same SATCOM links as for SATCOM data link; used globally for AOC communications.
- Link 2000+ program in Europe; state and FANS 1A-equipped aircraft are currently exempt.
- Preferred routing for those who equip with FANS 1A/ATN; current coverage is INMARSAT; NAT mandate is possible.
- Preferred routing for those who equip with FANS 1A/ATN
- Preferred routing for those who equip with FANS 1A/ATN
- Preferred routing for those who equip with FANS 1A/ATN
- Preferred routing for those who equip with FANS 1A/ATN
- Preferred routing for those who equip with FANS 1A/ATN
- Some DoD aircraft have capability, but minimal ground infrastructure exists
- No current mandate. FAA GBAS is LAAS
- No current mandate. FAA SBAS is WAAS
- US DoD implementation of GBAS
- PRNAV in Europe uses RNP-1 containment in NAM RNAV 1 is mandate for arriving/departing at OEP Airports;
- In Asia, 2NM navigation accuracy will be mandated at or above FL290; in NAM, RNAV 2 will be mandated at and above FL180
- CONUS may require RNP-0.3 by mid term (2011-2015) where beneficial for approaches.
- In NAM, mandated where beneficial
- At & above FL290 en-route by mid term (2011-2015)
- Mandatory in PAC on RNP-4 tracks
- Supports terminal and en route operations
- Controller may refuse access to RVSM airspace if aircraft not equipped; formations need 2000’ vert sep regardless of equipage
- Australia was first in 2009. US and Europe considering implementation in 2017. CONUS mandate is 2020.
- Outside of initial European states, Air Force requires Mode S to support TCAS II on troop-carrying aircraft
- Initial countries in 2009: Germany, France, and UK terminal areas; will extend to Switzerland, Malaysia, and possibly others
- Mode S folding need is from NLT FY08 to FY15 per AF/XOR. Digital Mode S ELS transponder is a prerequisite for Mode S
- Requirement comes from Nav Safety Letter and is 2005 on all passenger/troop-carrying aircraft
- Requirement comes from Nav Safety Letter and is 2005 on all passenger/troop-carrying aircraft; upgrade to 406 MHz required 09
- Requirement comes from Nav Safety Letter and is 2005 on all passenger/troop-carrying aircraft
- Requirement comes from Nav Safety Letter and is 2005 on all passenger/troop-carrying aircraft; state aircraft mandate in
- Requirement comes from Nav Safety Letter and is 2005 on all passenger/troop-carrying aircraft
- Requirement comes from Nav Safety Letter and is 2005 on all passenger/troop-carrying aircraft
- When necessary for military missions, CNS/ATM functions can be turned off

For more details on world-wide CNS/ATM requirements and dates, see the Strategic Projection of Airspace Requirements and Certifications (SPARC) website: https://sparc.qdmetrics.com/SPARC/home.jsp
Appendix A:
CNS/ATM Policy

- U.S. is a signatory to International Civil Aviation Organization (ICAO) along with 185 other countries
- Flight procedures outlined by ICAO are implemented by Federal Aviation Regulations (FAR)
  - FARs carry the rule of law . . . violations of FARs are equal to violations of law
- DoD Directive 4540.1, Use of Airspace by United States Military Aircraft and Firings Over the High Seas, Jan 81
  - “When practical and compatible with the mission, U.S. military aircraft operating over the high seas shall observe International Civil Aviation Organization (ICAO) flight procedures.”
  - “Normally routine point-to-point and navigation flights shall follow ICAO flight procedures.”
- Capstone Program Management Directive (PMD), 14 Jul 97, CAPSTONE PROGRAM MANAGEMENT DIRECTIVE (PMD) for Global Air Traffic Operations/Mobility Command and Control (GATO/MC2) CAP-PMD-GATO/MC2, No. 01-97
- AFMCGM 63-01
Appendix B:
CNS/ATM Glossary

1090 ES – 1090MHz Extended Squitter – The internationally common 3 ADS-B link. [A “Squitter” is a spontaneous transmission containing information about the aircraft’s location, equipage, and intent] It is based on Mode S and uses the Mode S transponders as a basis for operation. Therefore, no additional “boxes” and antennas are required. [see "VDL-4" and "UAT"]

8.33KHz spacing – Because of congested voice communications in Europe, it was necessary to divide the 25 kHz VHF band (118-137MHz) into three 8.33 kHz bands. Currently implemented above FL 245.

AC – Advisory Circular: Produced by the FAA, the AC provides guidance material that is not mandatory and does not constitute a regulation. It outlines a method of compliance with the rules. In lieu of following this method without deviation, the applicant may elect to follow an alternative method, provided the FAA determines that the alternative method is an acceptable means of complying with FAA regulations. Because the method of compliance presented in an AC is not mandatory, the terms "shall" and "must" apply only to an applicant who chooses to follow this particular method without deviation.

ACARS – Aircraft Communications Addressing and Reporting System: A digital data link network providing connectivity between aircraft and ground end systems (command and control, air traffic control, etc.)

ACAS II – Airborne Collision and Avoidance System: International equivalent to TCAS II, version 7 [see “TCAS”]

Accuracy – The degree of conformance between calculated position and true position

ACO – Aircraft Certification Office: An FAA organization, there are many ACOs throughout the USA. Primary concern is operational safety, which includes monitoring the safety performance of certified or approved aeronautical products, and monitoring FAA representatives. It makes findings of compliance, based upon the showing of compliance to the FARs, on products presented to the FAA for certification.

ACTFAST – ATC Communications Test Facility and Avionics System Test: The ACTFAST is located at Edwards AFB, CA. It benefits program offices, integrators, and test centers by serving as an air traffic control ground end system for ground and flight test. ACTFAST allows users to test air traffic control data link applications over a live network.

ADL – Aeronautical Data Link: A digital network providing communication between aircraft and ground systems.

ADS-A – Automatic Dependent Surveillance-Addressed: Also known as ADS-C. Automatic Dependent Surveillance-Addressed is a data link application that provides for contracted services between ground systems and aircraft. Contracts are established such that the aircraft will automatically provide information obtained from its own on-board sensors, and pass this information to the ground system under specific circumstances dictated by the ground system (except in emergencies).

ADS-B – Automatic Dependent Surveillance-Broadcast: A vehicle or object will broadcast a message on a regular basis which includes its position (such as lat, long, altitude), velocity, and possibly other information. These position reports are based on accurate navigation systems. There are three accepted links, ADS-B: 1090 Extended Squitter [see “1090 Extended Squitter”], Universal Access Transceiver [see “UAT”], and VDL-4 [see “VDL-4”]. Military aircraft will use 1090 ES with few exceptions.

ADS-C – Automatic Dependant Surveillance-Contract: ADS-C is the same as ADS-A.

AEEC – Organization that creates value for airlines and the aviation industry by developing engineering standards and technical solutions for avionics, networks, and cabin systems throughout the aircraft that foster increased efficiency and reduced life cycle costs throughout the aviation community.

AERO-C – INMARSAT satellite service providing store-and-forward message capability. Aero-C is for non-safety use only and provides data rates of approximately 600bps.

Appendix B:  
CNS/ATM Glossary (cont’d)

AERO-I: INMARSAT satellite service providing intermediate gain multi-channel digital voice/circuit-mode data, fax, and packet data services; operates in the spot beams (which have lower power requirements) of the new generation INMARSAT-3 satellites.

AERO-M (aka “Mini-M Aero”): INMARSAT satellite service providing single channel, two-way voice and data communication services. Aero-M is for non-safety use only and provides data rates of approximately 2400bps.

AFFSA – Air Force Flight Standards Agency: Located at Tinker AFB, OK, AFFSA develops, standardizes, evaluates, and certifies procedures, equipment, and standards to support global flight operations and to centrally manage ATCALS for the AF.

AFMSS – AF Mission Support System: A family of systems that provide automated mission planning materials, preparation, and post-mission debriefing capabilities. The AFMSS family includes the Mission Planning Subsystem (MPS-UNIX based), the Portable Flight Planning Software (PFPS-PC based) and the forthcoming Joint Mission Planning System (JMPSS-PC Based). Both the MPS and PFPS consist of the following software components:

Core - Basic mission planning functions.
Avionics/Weapons/Electronics (A/W/E) - Specific aircraft planning functions. AMC uses a single A/W/E concept called Tanker, Airlift, & Special Mission (TASM). TASM is a common A/W/E core with the integration of individual aircraft modules.
Flight Performance Module (FPM) - Aircraft flight performance data (takeoff & landing data, fuel calculations, etc.).
Combat Weapons Delivery Software (CWDS) - Used by ACC aircraft for gravity weapons delivery.
Precision Guided Munitions (PGM) A/W/E - Used by ACC aircraft for PGM mission planning. There is a unique planning module for each different PGM. PFPS incorporates a limited PGM planning capability.

AFN – ATS [Air Traffic Services] Facilities Notification: ATS Facilities Notification (AFN) provides for the initiation of FANS-1/A data exchange between a pilot and controller via data link. AFN is initiated by the pilot prior to entering FANS-1/A airspace and is essentially an introduction between the aircraft and the Air Traffic Services (ATS) facility.

AFTN – Aeronautical Fixed Telecommunications Network: The standard ground – ground communication network used by ATC; it’s based on teletypewriter technology.

AIMS – ACR/BS/JFF/MK12 System Program Office: Located at Warner-Robins ALC, the AIMS program office oversees the compliance and overall performance of surveillance systems for the DoD. For example, interrogators and transponders perform AIMS functions and therefore are required to be certified by the AIMS SPO.

AOA – ACARS Over Aviation VHF Link Control: AOA is an attempt at gaining some early benefits of digital technology without the full risk of ATN. It is a step between full ACARS and full ATN. The most significant near-term benefit is the reduction of VHF congestion problems by transitioning traffic to the VDL-2 air/ground network. AOA allows airborne and airline host applications to remain unchanged (character format). The airborne AOA process packages the data so that it can be routed over the digital VDL-2 network. At some point on the ground, the data is restored to its original format for processing by legacy airline host applications. It moves data at 31.5kbps vs. ACARS’ 2.4kbps service.

AOC – Airline Operational Control [aka Aeronautical Operational Control]: Operational messages used between aircraft and airline dispatch centers or, by extension, the DoD to support flight operations. This includes, but is not limited to, flight planning, flight following, and the distribution of information to flights and affected personnel.

APV – Approach Procedure with Vertical Guidance: A non-precision approach using GPS that has some vertical guidance. This vertical guidance is less precise than that for a precision approach (e.g., ILS) and therefore the approach minimums (weather, ceiling, and visibility) are higher.

AQP – Avionics Qualification Program: A series of tests and compliance procedures intended to validate and qualify avionics suites for operation over the ARINC network.

ARINC – A global industry leader depended on by airlines around the world to deliver flexible, highly-reliable, cost-effective solutions, to evolve and adapt technology that optimizes and expands customer capabilities, and to seamlessly meld a true GLOBALink of voice and data communications.

ARTCC – Air Route Traffic Control Center: United States facilities responsible for controlling instrument flight rules aircraft en route in a particular volume of airspace at high altitudes between airport approaches and departures. There are twenty-one ARTCCs in the United States National Airspace System (NAS).
Appendix B: CNS/ATM Glossary (cont’d)

ATN – Aeronautical Telecommunications Network: An internetwork architecture that allows ground/ground, air/ground, and avionic data sub networks to interoperate by adopting common interface services and protocols based on the ISO OSI Reference Model.

ATOP – Advanced Technologies and Oceanic Procedures: Replaces systems at the Anchorage, New York, and Oakland centers. The new system will collect, manage, and display oceanic air-traffic data (including electronic flight-strip information) on the computer displays.

ATSU – Air Traffic Services Unit: A unit established for the purpose of receiving reports concerning air traffic services and flight plans submitted before departure. It is a generic term meaning air traffic control unit, flight information center, or air traffic service reporting office.

Availability – Percentage of the time that the required accuracy and integrity are useable to meet a specified flight phase.

BLOS – Beyond Line of Sight: Oceanic or remote communications that are not line-of-sight (LOS). SATCOM and High Frequency Data Link (HFDL) are examples of BLOS data link systems.

BRNAV – Basic Area Navigation: Implemented in Europe in 1998 for altitudes above FL 095, it’s essentially an area navigation [RNAV] capability with an accuracy equivalent of RNP-5. BRNAV can be achieved using ground navigation aids, self-contained reference systems, GPS, or a combination thereof. [see http://www.ecacnav.com/rnav/b-rnav/default.htm]

CANSO – Civil Air Navigation Services Organization: The global voice of the companies that provide air traffic control. Founded in 1996, it represents the interests of the Air Navigation Service Providers (ANSPs) worldwide.

CAPSTONE – A joint industry and FAA Alaskan Region effort to improve Alaskan aviation safety and efficiency through installation of government-furnished Global Positioning System (GPS)-based avionics and data link communications suites in most commercial aircraft. Compatible ground systems, equipment, and services will also be provided. In addition to the avionics suites, it will deploy a ground infrastructure for weather observation, data link communications, surveillance, and Flight Information Services to improve safety and enable eventual implementation of new procedures. The demonstration areas are non-radar environments where most of the air carrier operations have been limited to VFR. [see http://www.alaska.faa.gov/capstone ]

CAT I – Category I: An instrument approach or approach and landing with a decision altitude (height) or minimum descent altitude (height) not lower than 200 ft and with either a visibility not less than 1/2 statute mile, or a runway visual range not less than 1800 ft. [ref AC 120-29a]

CAT II – Category II: An instrument approach or approach and landing with a decision height lower than 200 ft but not lower than 100 ft and a runway visual range not less than 1200 ft. Runway lighting criteria must be met and be operational. The FAA approves U.S. carriers for Cat II operations in specific aircraft. It also approves specific runways at specific airports for Cat II operations. [ref AC 120-29a]

CAT III – Category III: An instrument approach or approach and landing with a decision height lower than 100 ft, or no decision height, or a runway visual range less than 1200 ft. (Adapted from ICAO - IS&RP Annex 6). Category IIIa: An instrument approach and landing with a decision height lower than 100ft, or no decision height and a runway visual range not less than 700 ft.

Category IIIb An instrument approach and landing with a decision height lower than 50ft, or no decision height and a runway visual range less than 700 ft but not less than 150 ft. [FAA Note - the United States does not use Decision Heights for Category IIIb.] Category IIIc: An instrument approach and landing with or without a decision height, with a runway visual range less than 150 ft.

The aircraft uses its FMS, autopilot, and auto-throttles for approach and landing. Runway lighting criteria must be met and be operational. The FAA approves U.S. carriers for Cat III operations in specific aircraft. It also approves specific runways at specific airports for Cat III operations.

CDTI – Cockpit Display of Traffic Information: Avionics technology that displays the relative location of nearby aircraft to enhance the pilot’s awareness of the surrounding environment.

CMU – Communication Management Unit: The CMU performs two important functions: it manages access to the various data link sub networks and services available to the aircraft and hosts various applications related to data link. It also interfaces to the flight management system (FMS) and to the crew displays.

CNS/ATM – Communication, Navigation, Surveillance/Air Traffic Management: CNS/ATM is a system based on digital technologies, satellite systems, and enhanced automation to achieve a seamless global Air Traffic Management in the future. Modern CNS systems will eliminate or reduce a variety of constraints imposed on ATM operations today.
Appendix B:
CNS/ATM Glossary (cont’d)

Continuity – Probability that system will maintain its performance level for the duration of an operation presuming system availability at the beginning of that period.

CPDLC – Controller-Pilot Data Link Communications: The CPDLC application provides for the exchange of flight planning, clearance, and informational data between a flight crew and air traffic control. This application supplements voice communications and in some areas will likely supersede it in the future.

CRC – Cyclical Redundancy Check: A CRC, or polynomial code checksum, is a non-secure hash function designed to detect accidental changes to raw computer data, and is commonly used in digital networks.

CRD 1 – Capstone Requirements Document 1: Establishes requirement to equip airlifters, tankers, operational support/DV, aero medical evacuation, and "special use" aircraft (e.g., JSTARS E-8 and AWACS E-3) to operate in civil airspace to the extent required by their missions.

CRD 2 – Capstone Requirements Documents 2: Properly known as Phase II annex to CRD 1, it covers all aircraft not listed in CRD 1.

CVR – Cockpit Voice Recorder: A CVR is a flight recorder used to record the audio environment in the flight deck of an aircraft for the purpose of investigation of accidents and incidents. This is typically achieved by recording the signals of the microphones and earphones of the pilots’ headsets and of an area microphone in the roof of the cockpit. Each recorder is equipped with an Underwater Locator Beacon (ULB). The device, called a "pinger," is activated when the recorder is immersed in water. The beacon can transmit from depths down to 14,000 feet. It records the last continuous 30 min (2 hours for solid state digital units) and then recycles.


DAP – Down link Aircraft Parameters: This is data down-linked to the ground, via the Mode S transponder, that provides information about the aircraft operations and planned route. The three types of DAP are “basic functionality” (flight ID, transponder capability, and flight status), “enhanced” (EHS) and “elementary” (ELS) surveillance functionality providing flight intent information.

DAR – Designated Airworthiness Representative: An individual appointed by the FAA who may perform examination, inspection, and testing services necessary to the issuance of certificates. There are two types of DARS: manufacturing and maintenance. A Manufacturing DAR must possess aeronautical knowledge, experience, and meet strict qualification requirements. A Maintenance DAR must hold a mechanic's certificate with an airframe and power plant rating.

DER – Designated Engineering Representative: An individual who can approve engineering data, recommend approval of test plans and witness engineering tests on behalf of the FAA.

DGPS – See GPS-D

DME – Distance Measuring Equipment: The DME is a VHF navigation aid that is used by an aircraft to determine its distance from a known point (the DME location).

DRVSM – Domestic RVSM: This is the US program to require RVSM over CONUS.

DTED – Digital Terrain Elevation Data: An NGA product, DTED is a uniform matrix of terrain elevation values which provides basic quantitative data for systems and applications that require terrain elevation, slope, and/or surface roughness information for military applications.

EASA – European Aviation Safety Agency: Agency of the European Union (EU) which has been given specific regulatory and executive tasks in the field of civilian aviation, taking over functions of the Joint Aviation Authorities (JAA). The agency’s responsibilities include: giving advice to the EU for drafting new legislation; implementing and monitoring safety rules, including inspections in the Member States; type-certification of aircraft and components, as well as the approval of organizations involved in the design, manufacture and maintenance of aeronautical products; authorization of third-country (non EU) operators; safety analysis and research.

ECAC – European Civil Aviation Conference: International organization developed to promote the continued development of a safe, efficient, and sustainable European air transport system by harmonizing civil aviation policies and practices amongst its Member States and promoting understanding on policy matters between its Member States and other parts of the world.

EFIS – Electronic Flight Instrumentation System: Digital display that combines aircraft attitude and performance data from different sources on a single display.

EGI – Embedded GPS/INS: A military, self-contained navigation system which provides positioning, velocity, and acceleration data for the aircraft. The EGI receives signals from GPS. The EGI receiver tracks up to five satellites simultaneously. The single LRU contains a ring laser gyro INU and GPS functions.
Appendix B: CNS/ATM Glossary (cont’d)

EGNOS – European Geostationary Navigation Overlay Service: Europe's counterpart to WAAS [see "WAAS"].

EGPWS – Enhanced Ground Proximity Warning System: Honeywell's trade name for TAWS [see “TAWS”]. Designed to complement or replace the current functions of GPWS and provide terrain warnings in situations where the current GPWS does not.

The two new major functions are forward looking terrain alerting and terrain display. Both functions use the EGPWS self-contained worldwide airport and terrain databases, which are used in conjunction with aircraft position (from the FMS), barometric altitude (from Air Data System), and flight path information (from Air Data System) to determine potential terrain conflicts and providing much earlier alerting than is possible with the basic GPWS.

The EGPWS provides caution/warning-level alerts and then calculates corresponding envelopes. If these envelopes conflict with data in the terrain database, alerts are activated. The look-ahead caution alert is provided approximately 40 to 60 seconds before a potential terrain conflict. The look-ahead warning alert is provided approximately 20 to 30 seconds before such a conflict.

ELT – Emergency Locator Transmitter: A “Nav/Safety” item. A crash resistant box that emits a signal on VHF/UHF frequencies (121.5MHz, 243.0MHz and, in the future, 406.025MHz) to aid in locating a downed aircraft.

E-TCAS – Enhanced TCAS: A military-unique TCAS application for tankers that is used for air refueling rendezvous.

EUROCAE – European Organization for Civil Aviation Equipment: A nonprofit organization that was formed in Europe to provide a forum for resolving technical problems with electronic equipment for air transport. EUROCAE is similar to RTCA in the United States.

EUROCONTROL – European Organization for the Safety of Air Navigation: An intergovernmental organization made up of 38 Member States and the European Community whose primary objective is the development of a seamless, pan-European Air Traffic Management (ATM) system that is safer, performance-driven, and environmentally sustainable.

FANS-1/A – Future Aircraft Navigation System 1/A: A set of operational capabilities centered around direct data link communications between the flight crew and air traffic control. Operators benefit from FANS-1/A in oceanic and remote airspace around the world.

FAR – Federal Aviation Regulations: Rules prescribed by the FAA governing all aviation activities in the United States.

FDE – Fault Detection/Exclusion: A GPS receiver processing scheme that autonomously provides automatic determination of which GPS satellite(s) tracked by the receiver is (are) causing the RAIM [see “RAIM”] alert. It requires six or more visible satellites. The FDE consists of two distinct parts: fault detection and fault exclusion. The fault detection part identifies the faulty satellite(s). Upon detection, fault exclusion follows and excludes the faulty satellite(s) from the GPS navigation solution. Flight in some civil airspace requires both RAIM & FDE.

FDR – Flight Data Recorder: A flight recorder used to record specific aircraft performance parameters for accident investigation, as well as analyzing air safety issues, material degradation, and engine performance. These devices are carefully engineered and stoutly constructed to withstand the force of a high speed impact and the heat of an intense fire. The exterior of the FDR is coated with heat-resistant bright orange paint for high visibility in wreckage, and the unit is usually mounted in the aircraft's tail section, where it is more likely to survive a severe crash. Each recorder is equipped with an Underwater Locator Beacon (ULB). The device, called a "ping," is activated when the recorder is immersed in water. The beacon can transmit from depths down to 14,000 feet. It records for 25 continuous hours.

FHA – Functional Hazard Assessment: Conducted at the beginning of the aircraft/system life cycle, it identifies and assesses each hazard (e.g., loss of attitude indication), identifies the potential effects (e.g. hull loss) of each hazard, and classifies (e.g. catastrophic) each hazard based on the potential effects. Identifies the required level (e.g. “A”) of system development assurance. The FHA is used as the starting point for conducting the PSSA. (Ref. SAE ARP 4754)

FLEX TRACKS – Optimal flight routes calculated each day using the most recent weather information, these routes take advantage of prevailing wind patterns.

FMI – Frequency Modulation Immunity (aka P-ILS, Protected-ILS): European FM radio signals may interfere with aeronautical ILS, VOR, and VHF voice communications. Therefore, the affected countries require aeronautical radios be immune from these affects. FMI requirements refer to P-ILS and VOR receivers. Protection from VHF voice interference is covered by the ICAO VHF radio requirement and the stipulation that all new 8.33 kHz radios will meet ICAO requirements. Waivers, which are difficult/impossible to obtain, only allow unmodified aircraft to fly IFR flight plans. Unmodified aircraft must have suitable avionics for landing in existing/forecasted weather.
Appendix B: CNS/ATM Glossary (cont’d)

FMS – Flight Management System: A computer system that uses a large database to allow routes to be preprogrammed and fed into the system by a means of a data loader. The system is constantly updated with respect to position accuracy by reference to conventional navigation aids. The sophisticated program and its associated database insure that the most appropriate aids are automatically selected during the information update cycle.

Free Flight – A safe and efficient operating capability under instrument flight rules in which the operators have the freedom to select their path and speed in real time.

GALILEO – Europe’s satellite positioning system. Unlike GPS that does not guarantee complete and unrestricted availability, Galileo is a full-time civil system. Will include a “flag” in the data stream for loss of system accuracy, to warn users of degraded operation - a feature GPS does not have. Space component expected to be in place by 2008. Planned to provide global coverage with 30 core satellites (workable with 24). Eventually expand to 40 satellites orbiting at 12,640 miles. Designed to offer layered capability to users with and without fees and can be fully interoperable with GPS hardware.

GANS – Global Access, Navigation and Safety: An umbrella avionics program that integrates GPS, navigation and safety equipment, Navigation Warfare (see “NAVWAR”), avionics modernization, military ground-based infrastructure, Global Air Traffic Management (GATM), and the Joint Precision Approach and Landing System [see “JPALS”].

GAT – General Air Traffic: This designation refers to aircraft flying under civil aviation rules on civil aviation routes. [see “OAT”]

GBAS – Ground-Based Augmentation System: The ICAO defines GBAS as a system that augments ground systems (typically at an airport) with equipment similar in functionality to a GPS satellite. This augmentation allows an aircraft to determine its vertical/lateral position to very great accuracy. The ultimate goal is CAT IIIIC operation. The US LAAS is a GBAS.

GLONASS – Global Navigation Satellite System: Russia’s satellite positioning system. It has collapsed to only seven satellites, with improvements and further launches uncertain.

GLS – GNSS Landing System: A safety-critical system consisting of the hardware and software that augments the GPS SPs to provide for precision approach and landing capability (much like the ground-based ILS does now). The positioning service provided by GPS is insufficient to meet the integrity, continuity, accuracy, and availability demands of precision approach and landing navigation. The GLS augments the basic GPS position data in order to meet these requirements. These augmentations are based on differential GPS concepts.

GMU – GPS-based Monitoring Unit: The size of a small suitcase, it features an on-board monitoring and recording unit composed of a GPS receiver, computer, and flight deck windows antennae. An alternative to the HMU [see "HMU"] as a means to check aircraft for RVSM compliance.

GNSS – Global Navigation Satellite System: Functions are to provide enroute/terminal navigation with non-precision approach and precision approach capabilities. The U.S. system is GPS.

GPS – Global Positioning System: A 24 satellite constellation in six orbits 11,000 miles above the earth. Positioned so that users can receive signals from six satellites nearly 100% of the time at any point on Earth. Developed by DoD primarily for military purposes. When receiving signals from at least four satellites, a GPS receiver can determine latitude, longitude, altitude and time. Without RAIM [see “RAIM”] and FDE [see "FDE"], the user can not be certain that GPS meets the accuracy, availability, and integrity requirements critical to safety of flight. [see http://www.trimble.com]

GPS-SPS – GPS Standard Positioning Service: One of two levels of GPS service used by both the military and civil aviation community in order to support aircraft navigation and landing. Since a Presidential Order turned Selective Availability off, SPS horizontal accuracy is about 10 meters (vs. about 100 meters when SA is on).

GPS-PPS – GPS-Precise Positioning Service: The military maintains exclusive access to the more accurate "P-code" (pseudo random code). It's ten times the frequency of the civilian C/A code. It is much more accurate, much harder to jam and to spoof. Now that DoD has implemented anti-spoofing, P-code is encrypted to form Y-code. Horizontal accuracy is less than 10 meters.

GPS-D – Differential GPS: DGPS is a GPS augmentation that uses differential corrections to the basic satellite measurements that are performed within the receiver. DGPS is based upon accurate knowledge of the geographic location of Earth reference stations. This knowledge is used to compute corrections to GPS parameters, error sources, and/or resultant positions. These differential corrections are then transmitted to GPS users, either from a ground-based station (e.g., LAAS) or from a satellite-based system (WAAS, EGNOS, GALILEO, etc). GPS receivers apply the corrections to their received GPS signals and compute a more optimum position. For a civil user, differential GPS can improve navigational accuracy from 100 meters to better than 10 meters.
Appendix B: CNS/ATM Glossary (cont’d)

HFDL – High Frequency Data Link: An ACARS communications media used to exchange data link messages between aircraft end-systems and corresponding ground-based HFDL ground stations. Using the unique propagation characteristics of high-frequency radio waves, the ground stations provide data link communications to properly equipped aircraft operating anywhere in the world.

HMU – Height Monitoring Unit: A passive, ground-based system that measures the geometric height of an aircraft for comparison with the geometric height of the flight level at which it is being flown. It consists of a set of ground stations arranged as a central site, with four additional receivers arranged in a square. Each site receives aircraft radar transmissions, from which the aircraft’s three-dimensional position is derived. The HMU calculates altimetry system error using meteorological information and the Mode-C/S height data.

ICAO – International Civil Aviation Organization: A major agency of the United Nations, ICAO codifies the principles and techniques of international air navigation and fosters the planning and development of international air transport to ensure safe and orderly growth. ICAO establishes international standards, recommended practices, and procedures covering the technical fields of aviation.

IFR – Instrument Flight Rules: The rules that govern the conduct of aircraft during instrument flight. These rules can apply when weather is clear and visibility is unlimited (e.g., when aircraft fly at high altitudes or when executing an instrument approach). Sometimes heard in the context of weather conditions at an airfield (e.g., “The field is IFR.”). This means that the airfield is below Visual Flight Rules (VFR) weather minimums.

II/SI Codes – Interrogator Identifier/Surveillance Identifier Codes: Mode S surveillance and communication functions are designed to allow Mode S interrogators with overlapping coverage to operate without any real-time coordination. This is made possible partly by the use of 15 II and the new 63 SI codes which uniquely identify each site. Transponders need to be able to support both code formats for the system to work, or SI codes cannot be used until all aircraft in a region of airspace are equipped. Operation with less than 100% equipage will result in overlapping interrogators having incomplete surveillance coverage. [http://www.eurocontrol.int/mode_s/FAQ/faqanswers.htm#4]

INMARSAT – The world's leading provider of global mobile satellite communications. INMARSAT provides voice and high-speed data services to almost anywhere on the planet - on land, at sea and in the air. INMARSAT services are delivered through the most versatile and reliable satellite network in the world. INMARSAT owns and operates eleven satellites in geostationary orbit 35,786km above the Earth, controlled from its headquarters in London via ground stations located around the globe.

INS – Inertial Navigation System: A self contained, dead reckoning system that senses the acceleration along the three axes of the aircraft and calculates the distance traveled from a reference point. Accuracy of the system decreases with time.

Integrity – Ability of a system to provide timely warnings or shut itself down when it shouldn't be used for navigation.


Jeppesen – An American company that specializes in aeronautical charting and navigation services, flight planning, pilot supplies, and aviation training. The company is a subsidiary of The Boeing Company. Jeppesen also publishes related software, some of which is used on its electronic flight bag product line. The Jeppesen navigation database is used in some USAF aircraft but most aircraft use NGA’s DAFIF database that includes military airspace.

JMPS – Joint Mission Planning System [aka "JUMPS"]: The follow-on Windows based mission planning system that replaces Mission Planning System (UNIX based) and Portable Flight Planning System. It has the following software components:

JMPS Framework - Contains the map display and combat mission planning functions.

Common Capabilities - Mission planning functions that are integrated with the JMPS Framework based on the aircraft requirements and are also used by other aircraft platforms (e.g., airdrop tool, air refueling tool, etc).

Unique Planning Component [UPC] – Contains the unique aircraft planning functions as well as the software for loading the mission planning data to the data transfer device for transfer to the aircraft. AMC will still use the Tanker, Airlift, & Special Mission (TASM) software, which contains all the UPCs for AMC aircraft. ACC creates a unique UPC for each different aircraft in the USAF inventory.

Flight Performance Module - No change from PFPS or MPS

Combat Weapons Delivery Software (CWDS) - Same configuration as used with PFPS or MPS

Precision Guided Munitions Planning Software (PGMPS) - One mission planning module with planning capabilities for all USAF PGMs.
Appendix B:
CNS/ATM Glossary (cont’d)

JPALS – Joint Precision Approach and Landing System: A deployable, interoperable, anti-jam system that uses differential GPS for guidance.

KPP – Key Performance Parameters: Requirements that come under Communications, Navigation, Surveillance, Nav/Safety, Situation Awareness, and Supporting Capability and are listed in the CRD1 and CRD2.

LAAS – Local Area Augmentation System: A ground-based augmentation to the GPS to provide Category I, II, and III (WAAS provides "near CAT I") precision approaches and precise surface navigation. The LAAS is intended to complement the WAAS and function together. It is the U.S. implementation of the ICAO-recognized GBAS [see "GBAS"]. [For more info, see http://www.caasd.org/proj/satnav/laas.html]


LNAV – Lateral Navigation: The new terminology for a GPS non-precision approach. The approach minimums for LNAV are higher than other types of area navigation (RNAV) due to the lack of vertical guidance. Aircraft relying on LNAV instrumentation must descend incrementally rather than following a fixed glide slope down to the decision height (DH). Consequently, the DH for LNAV approaches will, in most cases, be higher than for most LNAV/VNAV approaches. In some cases, though, such as when there is an obstacle close to the runway, LNAV's DH will be lower than in LNAV/VNAV approaches. An aircraft flying an LNAV approach descends directly after passing over an obstacle whereas on flying an LNAV/VNAV approach, it continues on its glide slope. [see http://gps.faa.gov/gpsbasics/lnav-text.htm]

MASPS – Minimum Aviation System Performance Standards: High level documents produced by RTCA that establish minimum system performance characteristics.

MASS – Military Airborne Surveillance System: An enhancement to ACSS' TCAS 2000 system that adds rendezvous and formation station keeping capabilities.

MFD – Multi Function Display: Cockpit display with multiple views that shows aircraft information

Mini-SR&O – Mini System Requirements & Objectives: This publicly releasable document is produced by a USAF aircraft integrator in order to document the specific features, options, and deviations as compared to the baseline FANS-1/A system. This document is utilized by Air Traffic Service Providers (ATSPs) around the world to understand a specific aircraft configuration and attempt to ensure end-to-end interoperability.


Mode S – Mode Select: An evolutionary replacement for the Air Traffic Control Radar Beacon System (ATCRBS). The primary role of the Mode S transponder is to "selectively" respond to interrogations (as opposed to responding to all interrogations) from a ground sensor or a Traffic Alert and Collision Avoidance System (TCAS) to provide airborne data information including identification (24-bit code), equipage, and altitude. [see "DAP" and "II/SI Codes"] [see http://www.eurocontrol.int/mode_s/FAQ/faqanswers.htm#4]

MOPS – Minimum Operational Performance Standards: Standards produced by RTCA that describe typical equipment applications and operational goals and establish the basis for required performance. Definitions and assumptions essential to proper understanding are included as well as installed equipment tests and operational performance characteristics for equipment installations. MOPS are often used by the FAA as a basis for certification.
Appendix B: CNS/ATM Glossary (cont’d)


MSO – Military Standard Order: Like the FAA’s TSO [see "TSO"]. GPSs with an MSO will be considered equivalent to those with a TSO.

NAS – National Airspace System: One of the most complex aviation systems in the world that enables safe and expeditious air travel in the United States and over large portions of the world's oceans.

NATS – North Atlantic Track System: Generated twice a day to provide the most fuel efficient routes for aircraft crossing the North Atlantic. Since the tracks are westbound during the day they are primarily set up to avoid the eastbound jet stream. Similarly at night when the flow of aircraft is mainly from North America to Europe they are generated to take advantage of the jet stream since this high velocity wind is generally flowing from west to east. There are days when the jet stream is not west to east but these are rare.

NATS – National Air Traffic Services: The United Kingdom's air traffic services are privatized and provided by NATS, a private public partnership owned by a consortium of UK airlines, the NATS staff, and the government.

NAVWAR – Navigation Warfare: Protect military access to GPS in a challenged environment.

NIMA – National Imagery & Mapping Agency: Now known as National Geospatial-Intelligence Agency [see NGA].

NOTAM – Notices To Airmen: Aviation information (e.g., status of airfield lighting, runways; departure/enroute/arrival navigation aid status; info on ATC facilities, etc.) distributed to all airspace users.

OASIS – Operational And Supportability Implementation System: The improved automated flight service station system that integrates flight data processing with new weather graphics and interactive briefings.

OAT – Operational Air Traffic: Flights that are operating subject to military ATC rules and procedures, usually off published airways but sometimes on TACAN routes, and usually under military control.

OFP – Operational Flight Program: Software programmed into aircraft’s avionics systems. Each system (e.g., radar, central computer, etc) is reviewed and updated regularly.

ORT – Owner Requirement Tables: The ORT stores specific aircraft and operational data such as speed dialing of telephone numbers, selections of preferred GESs, audio interface characteristics, satellite identification, frequencies of channels, spot beam identification, GES identification, GES spot beam support table, and satellite location.

On-Off – Air Force requirement for operational security that allows the crew to shut off aircraft emitters.

Pacer CIRG – Compass Radar and Global Positioning System: KC-135 upgrades that also include four multifunctional displays, two flight management systems, TCAS, and color weather radar. Some additional modifications under the “block 30” program include: EGPWS, RVSM, FDR, CVR, and ELT [see “EGPWS”, “RVSM”, “FDR”, “CVR”, & “ELT”].

P-ILS – See FMI

PPS – See GPS-PPS

PSSA – Preliminary System Safety Analysis: Provides preliminary information, through discussion and analyses (e.g. FTA, FMEA, etc.), that the anticipated system design can meet the requirements, qualitative and quantitative, for each hazard. The PSSA process uses system design information as input, while at the same time generating derived safety requirements. The process is therefore iterative, and the document is updated throughout the development. Each version is less preliminary than the prior version. [Ref. SAE ARP 4754]

PSAC – Plan for Software Aspects of Certification: For (each element of) software associated with equipment being proposed for certification, the software developer describes and justifies how, and at what level, they will meet the objectives of DO-178B. [see DO-178B, section 11.1 for the required contents of a PSAC]
Appendix B:
CNS/ATM Glossary (cont’d)

PRNAV – Precision Area Navigation: Defines European RNAV operations in terminal areas which satisfy a required track-keeping accuracy of ±1 NM for at least 95% of the flight time. This level of navigation accuracy can be achieved using DME/DME, GPS or VOR/DME. It can also be maintained for short periods using an inertial system. The length of time that a particular IRS can be used to maintain P-RAIM accuracy without external update is determined at the time of certification. [see http://www.ecacnav.com/p-rnav/whatis.htm]

RAIM – Receiver Autonomous Integrity Monitoring: RAIM is a two-step process. First, the receiver has to determine if five or more working satellites are above the horizon and in the proper geometry to make RAIM available. Second, it must determine if the RAIM algorithm indicates a potential navigation error, based upon the range solutions from those satellites. In other words, when the receiver indicates a “RAIM-not-available” alarm, it's saying, “there may/may not be something wrong with the GPS navigation solution, but I don't have enough satellite information to know for sure.” If it indicates a “RAIM error” alarm, it's saying, “I have enough satellites available and there's something wrong with one of them and the GPS navigation solution in general.” Flight in some civil airspace requires RAIM and FDE. [see “FDE”]

P-RAIM – Predictive RAIM: Determines RAIM availability for the ETA at the destination airport. While en route to the destination, predictive RAIM is automatically revised as the receiver continually calculates a new ETA. It's critical to understand that just because the receiver predicts RAIM will be available at the destination, it doesn't guarantee there will be sufficient satellite coverage on arrival, only that the receiver expects to have sufficient coverage to calculate RAIM. It's possible, for example, that a satellite could go unhealthy while en route. Or signals from satellites low on the horizon could be masked by terrain (the receiver's RAIM function has no way of knowing about terrain masking). P-RAIM does not have to reside in the GPS receiver. It can be provided by FAA Flight Service (US NAS only) and other ground based RAIM algorithms.

RCAT – Reconfigurable Cockpit Avionics Testbed: An 853 ELSG/NT resource located at MITRE, Bedford, MA that provides the Air Force with a hands-on demonstration, experimentation, training and test center. The RCAT is also used for advanced technology demonstrations that show how CNS/ATM equipment can be used to improve situational awareness and provide new command and control (C2) opportunities. The RCAT allows for a variety of instrumentation to be installed in its cockpit mockup.

RNAV – Area Navigation: Rather than fly established airways from one ground navigation aid to another (that possibly results in an inefficient “zigzag” route), RNAV ability allows a flight to go directly from departure to destination using virtual waypoints in space (“ghost” NAVAIDs, as it were).

RNP – Required Navigation Performance: Prescribes the system performance necessary for operation in a specified airspace, based on its required accuracy (RNP value). The basic accuracy requirement for RNP-X airspace is for the aircraft to remain within X nautical miles of the cleared position for 95% of the time in RNP airspace.

RNP_RNAV – RNP Area Navigation: A method of area navigation that includes the concept of navigation performance (RNP), area navigation (RNAV) and the elements of containment integrity and containment continuity.

RTCA – A private, not-for-profit corporation that develops consensus-based recommendations regarding CNS/ATM system issues. RTCA functions as a Federal Advisory Committee. Its recommendations are used by the FAA as the basis for policy, program, and regulatory decisions and by the private sector as the basis for development, investment, and other business decisions.

RVSM – Reduced Vertical Separation Minimum: Reduces the vertical separation between properly equipped aircraft to 1000 ft in RVSM airspace FL290-410, inclusive.

SAAAR – Special Aircraft & Aircrew Authorization Required: Special FAA authorization to conduct RNP approaches/missed approaches designated as such. Operators can be authorized for any subset of these characteristics: (1) ability to fly a published arc (also referred to as a RF leg); (2) reduced lateral obstacle evaluation area on the missed approach (also referred to as a missed approach requiring RNP less than 1.0)

SAASM – Selective Availability Anti-Spoofing Module: The next generation security functions for all GPS-PPS [see “GPS-PPS”] users, it is an architecture, not a chip. Selective Availability refers to the variations that the DoD can put in the GPS signal to keep unauthorized users from achieving the full accuracy of the GPS system. To do this, “noise” is introduced into the satellites’ clock data and slightly erroneous orbital data is sent. Keyed GPS-PPS receivers are capable of removing the SA alterations to the data messages. SA is currently set to zero to allow all users full access to the accuracy of the system. SAASM includes unclassified (black) keys; cryptography that supports direct Y-code acquisition, over-the-air rekeys, and tamper protection for all classified keys and algorithms. SAASM is intended to be 100 percent “backward compatible” (e.g., capable of being used with the current security keys and the existing GPS constellation) and will allow existing GPS receivers to distinguish between genuine and false GPS signals. SAASM will not impact SPS users. Anti-Spoof provides protection for authorized users by encrypting the PPS signal. Only keyed GPS receivers can decrypt and use this signal.
Appendix B: CNS/ATM Glossary (cont’d)

SAMS – Special Use Airspace Management System: A computer database that allows airlines, business aircraft operators and general aviation pilots to access the latest status information on special use airspace.

SARPS – Standards & Recommended Practices: Produced by ICAO, they become the international standards for member states. As the name implies, they are only “recommended” practices. It is up to each member state to decide how/if to implement them.

SATCOM – Satellite Communications: Communication service providing data, voice, and fax transmission via satellite. Allows aircraft to communicate in BLOS areas.

SBAS – Satellite Based Augmentation System: A complex infrastructure of ground-based monitors and control centers that augments the satellite-based position measurement system to meet accuracy, availability, and integrity requirements for navigation systems. The WAAS in the US, the EGNOS in the Europe, and the MSAS in Japan are examples of an SBAS.

SESAR – Single European Sky ATM Research: European air traffic control infrastructure modernization program. SESAR aims at developing the new generation ATM system capable of ensuring the safety and fluidity of air transport worldwide over the next 30 years.

SITA – A European based corporation that provides air transport communications and information technology (IT) solutions. Among other things, SITA is a provider of air-ground data link communication services for use in CNS/ATM environments.

(deleted SOIT, now n/a)

SPARC – Strategic Projection, Airspace Requirements, and Certification: A software application prepared by the 853 ELSG. It displays global and regional maps based on CNS/ATM implementation schedules; displays AF platform CNS/ATM schedules; analyzes global civilian flight routes; examines non-compliance impacts resulting from CNS/ATM implementations.

SPS – See GPS-SPS

SR&O – (Air Traffic Services) Systems Requirements and Objectives: A certification artifact which describes the aircraft configuration, certain characteristics of the operational environment, and the safety and interoperability requirements for the systems and functions that support ATS via FANS-1/A. [see also “Mini-SR&O”]

SSA – System Safety Assessment: Collects, analyzes, and documents verification that the system, as implemented, meets the system safety requirements established by the FHA and PSSA. The SSA includes such items as the final results of all analyses, a list of safety maintenance tasks and intervals.

STAR – Standard Terminal Arrival Route: Published instrument arrival procedure for an airfield. Smoothes the flow of arriving aircraft.

STARS – Standard Terminal Arrival System: An all-digital, integrated computer system with modern color displays and distributed processing networks. STARS workstation will display air traffic, weather overlays, and traffic flow management information for controllers.

STC – Supplemental Type Certificate: Certificate issued when an applicant has received FAA approval to modify an aircraft from its original design. The STC, which incorporates by reference the related type certificate, approves not only the modification but also how that modification affects the original design. Some military aircraft (e.g., the C-32, C-37, KC-10, E-4) have “type certificates,” meaning the FAA, not the military, provides certificate and the military’s integration contractor provides maintenance and logistics support.

SUA – Special Use Airspace: Airspace that has been identified for military use. Much of SUA is available for general use most of the time. It can be closed to non-military use with a two-hour notice.

SWIFT64 – INMARSAT high-speed data service which provides ample bandwidth for applications such as high-quality voice, email, internet and intranet access, large file transfer, and videoconferencing.

TACAN – Tactical Air Navigation: A military UHF navigation aid that provides azimuth and distance information to military aircraft from a fixed ground station. Some ground stations (VORTACs) can be used by both TACAN-only and VOR/DME equipped aircraft.
Appendix B: CNS/ATM Glossary (cont’d)

TAWS – Terrain Awareness Warning System: Equivalent to EGPWS [see “EGPWS”], it prevents Controlled Flight Into Terrain (CFIT) by providing three functions: Forward-Looking Terrain-Avoidance (FLTA), Premature Decent Alert (PDA) and Ground Proximity Warning.

TCAS – Traffic Alert Collision Avoidance System: A general term for a family of airborne devices that function independently of the ground-based ATC system and provide collision avoidance protection. TCAS I provides proximity warnings to pilots in the form of traffic advisories (TAs), which display the intruding "transponder-only" traffic relative to the TCAS-equipped airplane. Traffic advisories generally include the range, altitude, and bearing of the intruding airplane. TCAS II provides both TAs and recommended vertical escape maneuvers, known as resolution advisories (RAs). Resolution advisories provide pilots with information to change a vertical flight path or prevent a maneuver that could cause insufficient separation between airplanes. TCAS II also coordinates RAs between two TCAS II-equipped airplanes (i.e., each pilot would receive an RA that would not conflict with the other RA).

T2CAS – Terrain and Traffic Collision Avoidance System: Integrates TAWS [see "TAWS"] into TCAS [see "TCAS"] resulting in just one LRU for both functions. What that means to operators is that T2CAS will provide avoidance alerts based on the actual aircraft performance, not based on standard climb rates and an assumption that all critical functions are performing properly. This means elimination of nuisance conflict warning and alerts. For example, if an aircraft is approaching a mountain and one engine goes out, TCAS will factor in the decreased performance while accurately alerting pilots of any potential avoidance maneuvers. [see http://www.1-3com/acss/products/t2cas.asp]

TDMA – Time-Division Multiple Access: A system of multiplexing in which channels are established by sharing a transmission media divided into time slots by an automatic distribution system. Transmission is in the form of a series of frames, each of which is divided into a number of slots. Each slot position across frames is dedicated to a particular transmitter. Frame rates and data rates vary by system.

TERPROM – A proprietary digital terrain system, it provides highly accurate, passive terrain referenced navigation, predictive ground proximity warning, terrain following, and weapon aiming benefits; uses stored digital elevation data which, when combined with navigation system and radar altimeter inputs, provides accurate drift free navigation, by day or night in all weather conditions. Although used on A-10, F-16, and C-17, only the latter is using TERPROM for Nav/Safety.

TIS – Traffic Information Service: There is TIS and TIS-B; both provide transmission of ground-based traffic information to an aircraft. TIS is an alerting service (“intelligence” is on the ground vice the aircraft) and provides automatic traffic advisories from a Mode-S sensor to a Mode S-equipped aircraft. Transmitted data is tailored for specific aircraft. TIS-B is a surveillance service (“intelligence” is in aircraft) that broadcasts surveillance information (e.g., GPS position) from a ground source to aircraft that have appropriate receiver. Ground source and data link do not have to be Mode S. It has been demonstrated but MASPS are not complete. [see “CDTI”]

TLS – Transponder Landing System: A computer-generated localizer and glide slope signal. Enables ILS precision where traditional ILS can not be used (e.g., airports where nearby hills and/or obstacles can cause interference with the ILS). Required equipment: transponder, ILS receiver and display, and two-way radio. Unlike ILS that requires exact location, TLS can be located hundreds of feet from the desired runway centerline. The FAA has granted type acceptance (for Part 121 and 135 operators that fly with two crewmembers and dual nav/coms) and certified it to Cat 1 minimums. [see http://www.anpc.com]

TSO – Technical Standard Order: A minimum performance standard issued by the FAA for specified materials, parts, processes, and appliances used on civil aircraft.

UAT – Universal Access Transceiver: One of the three ADS-B link options. It is operational on an experimental basis in Alaska. MOPS are under development.

UHF – Ultra High Frequency: The military uses the UHF band for voice communications (225.0MHZ to 399.975MHZ).

VDL – VHF Data Link: Also known as VHF Digital Link, VDL is the LOS sub network supporting data communications that are sent over VHF frequencies. The traditional VHF voice radio can be used in conjunction with a data modem to send data messages over VHF frequencies.

(deleted VHD Mode 0, now n/a)
Appendix B: CNS/ATM Glossary (cont’d)

VDL-2 – VHF Data Link-Mode 2: A data link-only service designed to digitize VHF and improve the speed of the VHF link. VDL-2 will be used within the US and Europe as an interim data link solution for en route ATC functions. VDL-2 provides a 31.5 kbps channel rate.

(deleted VDL-3, now n/a)

VDL-4 – VHF Data Link - Mode 4: VDL-4 was developed by Sweden for ADS-B. It has SARP, MASPS, and MOPS and has some level of approval in Europe. It has a broadcast as well as a point-to-point communications capability. It’s single channel digital; uses multiple frequencies. Provides 9.6 - 31.5 kbps channel rate.

VFR – Visual Flight Rules: Simply, flight that is clear of meteorological conditions that require use of flight instruments for horizon and directional reference. The rules stipulate minimum ceiling and visibility requirements and distance from clouds.

VHF – Very High Frequency: The radio spectrum from 30MHz to 300MHz. VHF radios for CNS/ATM systems operate between 125.5 MHz and 136.5MHz. New radios must be compliant with ICAO SARPs (Annex 10, Volume 3). Most European states require 8.33 kHz channel spacing capability. All other states require 25 kHz channel spacing for new radios.

VIA – Versatile Integrated Avionics: A Honeywell LRU-based system derivative of the Airplane Information Management System developed for the Boeing 777. Certified on the Boeing 737NG for flight display functions, VIA is additionally certified on Boeing 717 and MD10 aircraft for flight management, flight displays, and fault warning. A benefit of the VIA is that it allows for a reduction in the total number of LRU’s required for an avionics upgrade.

VNAV – Vertical Navigation: An FMS Autopilot/Autothrottle capability that allows the aircraft to fly a computed vertical speed profile which associates lateral waypoints with given altitude/speed constraints. The vertical/speed profile can be either entered by the pilot or generated by the FMS. VNAV is not currently a required RNP RNAV capability; however, future versions of RNP RNAV will include VNAV requirements.

VNAV altitude can be based on either the aircraft’s barometric altimeter system (BARO VNAV) or on GPS. Without differential augmentation (LAAS/WAAS), BARO VNAV will be the primary method of VNAV altitude determination. Since BARO VNAV is affected by nonstandard temperature effects and requires an accurate local altimeter setting, use of BARO VNAV is prohibited on RNAV instrument approach procedures below VNAV DA(H).

WGS-84 – World Geodetic System 1984: Developed by the U.S. for world mapping. WGS 84 is an earth fixed global reference frame. It is the ICAO standard. [see http://www.wgs84.com/wgs84/wgs84.htm for a rather technical explanation]

WAAS – Wide Area Augmentation System: A GPS-based navigation and landing system that will provide precision guidance to aircraft at airports and airstrips where there is currently no precision landing capability. In order to provide "near CAT 1" [see "CAT I"] capability, WAAS improves the accuracy and ensures the integrity of information coming from GPS satellites. A complex infrastructure of ground-based monitors and control centers informs the user (by way of geostationary satellites) whether GPS can be safely used. It is the U.S. implementation of the ICAO-recognized SBAS. [see "SBAS"] [see: www.caasd.org/proj/satnav/waas.html]
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