Publication of Duncan Aviation

STRAIGHT TALK ABOUT AIRSPACE MODERNIZATION

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DUNCAN AVIATION

www.DuncanAviation.aero/straighttalk

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EDITOR'S NOTE

NextGen is a term we hear almost daily that refers to Airspace Modernization. We want our customers to know what Airspace Modernization encompasses and its relationship to other initiatives in and outside of the United States. The time for questions is mostly past, and we're now focusing on helping our customers understand what equipment is available. Retrofitting business aircraft with NextGen-compatible equipment is a significant investment, and we want to get as much information in front of our customers as possible. To an extent, every aircraft in US airspace will be affected, and we want to arm you with the right information so you can make informed decisions.

There is much to understand on the topic of NextGen (Next Generation Air Transportation System). We believe our efforts to find and condense this information should address many of your concerns. This Straight Talk book gives an overview of NextGen, providing a simple explanation of the many systems, standards, and policies and procedures that will ensure safe and efficient aircraft operations through air-transportation modernization

We believe Duncan Aviation is on the cutting edge of all avionics technology, and the subject of NextGen is no different. We have thoroughly researched the topic and talked with hundreds of customers to develop the most valuable information we can provide.

There are a number of subjects and systems that fall under the auspices of NextGen. We realize that you may want a more detailed explanation of some of these concepts and technologies. Therefore, we have created other Straight Talk books specific to a number of them. Visit *www.DuncanAviation.aero/straighttalk* to see our complete collection.

Duncan Aviation acknowledges the FAA Engineering and Safety Groups, Aircraft Electronics Association, and the avionics manufacturers who are working on the products to make your flying safer and easier.

As always, we look to improve ourselves and our knowledge. Feel free to contact our avionics experts to answer any of your questions and talk about your challenges as the need arises.

Duncan Aviation Avionics Sales Team

WHAT IS NEXTGEN?

Most people in business aviation have heard about the FAA's vision for the modernization of national airspace management and control called NextGen (Next Generation Air Transportation System). The concept evolved from modernization initiatives started during President Bill Clinton's administration.

The goal of the NextGen initiatives is to create capabilities that make air transportation safer and more reliable while increasing the capacity of our airspace and reducing aviation's environmental impact. Projections indicate that air traffic will increase by 20% over the next decade. The systems being implemented now are needed to accommodate the increasing demands on our national airspace system. In addition, the FAA is working with its global counterparts to ensure that NextGen is compatible with current and future worldwide airspace requirements.

The term NextGen has been mentioned frequently over the last few years because the vision is quickly becoming a reality. The FAA is working with industry organizations and manufacturers to implement the plan, which it believes will increase safety and efficiency of US airspace by providing more complete and reliable traffic and weather data to pilots and controllers.

With the increased traffic, very light jets, UAVs (unmanned aerial vehicles), and commercial space flight in our near future, there is an immediate need to be proactive in upgrading the national airspace system.

WHAT DOES NEXTGEN ENCOMPASS?

- Incorporate digital communication applications to decrease errors and inefficiencies in air traffic controlling
- Improve technologies that permit aircrews to make more informed decisions about potential hazards
- Reduce lateral separation to accommodate true departure to destination flights and increase aircraft densities in critical flight routes (North Atlantic, etc.)
- Add improvements and efficiencies to decrease fuel burn in the NAS (National Airspace System)

THE BENEFITS OF NEXTGEN

The key advantages of NextGen are:

- Increased safety
- Reduced emissions
- Reduced delays
- Reduced airport congestion
- Reduced fuel use

NextGen systems and procedures are currently being deployed, and some operators are already seeing benefits. Additional benefits to both the NAS operators and users will come as NextGen deployment continues during the next decade.

The timing will depend greatly on aircraft owners/operators and their willingness to invest in the on-board systems and training needed to use the NextGen infrastructure effectively. The benefits are clear and make good business sense. The incentives for aircraft operators to upgrade sooner rather than later will come as a result of preferential treatment for those properly equipped. You may hear the phrase, "Best equipped, best served." According to the FAA's NextGen Annual Report for 2020, between 2010 and 2019, implemented NextGen capabilities accrued more than $7 billion worth of benefits divided into these categories:

- Reduced accidents: 5%
- Fuel savings: 17%
- Other aircraft operating cost savings: 21%
- Passenger travel-time savings: 57%

THE INFRASTRUCTURE OF NEXTGEN

NextGen is dependent on operators upgrading their aircraft with the modernized systems and on the FAA overhauling the airspace infrastructure. The greatest NextGen infrastructure achievement to date has been the deployment of ADS-B (Automatic Dependent Surveillance-Broadcast) stations. At the time of this publication, all ground stations are complete.

Another significant system that makes up the NextGen infrastructure is the ERAM (En Route Automation Modernization) program. As of March 2015, ERAM has replaced the En Route Host computer,

transitioning the ground-based air traffic control system to a satellite-based system of air traffic management. Now complete, this software allows aircraft to file the most direct route from departure to destination and make in-flight route changes quickly and efficiently.

The change in infrastructure to support the NextGen initiatives is costly. Here are some statistics gathered from the US Department of Transportation that give an idea of current and future expenses.

- $50 million to display ADS-B data for use by controllers in the high-altitude environment
- $400 million to develop an interface that provides controller/pilot message processing and displays information to controllers in the en-route centers
- $117.7 million for SWIM (System Wide Information Management) Segment 1 only to modernize and enhance its flight data processing and external interfaces with terminal air traffic control and the traffic flow management systems

With the proper equipment on your aircraft and the new air traffic control system, controllers will be able to manage 1,900 aircraft at one time instead of the 1,100 they can handle today and 480-560 in an 8-hour period. With things like weather integration, conflict resolution, better cockpit communications, and strategic flow management, we will see more airspace flexibility as a result.

SYSTEMS OF NEXTGEN

In the FAA's NextGen Implementation Plan Document (dated March 2011), the FAA outlines NextGen today as encompassing the following aircraft systems and technologies:

ADS-B—Automatic Dependent Surveillance Broadcast (Out and In)

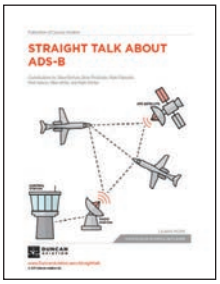
RNAV/RNP—Area Navigation/Required Navigation Performance are part of a Performance Based Routing system, including ITA (Initial Tailored Arrival)

WAAS—Wide Area Augmentation System with LPV (Localizer Performance with Vertical Guidance) approach procedures

FANS/CPDLC—Future Air Navigation System and Controller Pilot Data Link Communications

In this section, we will touch on each of these systems and technologies to provide general descriptions and guidance.

ADS-B



www.DuncanAviation.aero/resources/straight-talk/ads-b

ADS-B is an aircraft and satellite-based transmission system that can be broken into two primary functions: ADS-B Out and ADS-B In. An aircraft equipped with ADS-B Out works by sending GPS-derived position and velocity data from the aircraft, through an ADS-B-modified Mode S Transponder or a UAT (Universal Access Transceiver), to other aircraft, ground vehicles, and ground stations for the purpose of ATC (Air Traffic Control) and coordination.

ADS-B Out allows an aircraft to transmit information to ATC ground stations and to properly equipped aircraft.

Position data will be automatically broadcast from all ADS-B-Out-equipped aircraft. ATC ground stations and ADS-B-In-equipped aircraft will receive this data. ADS-B Out has been mandated by the FAA in the airspace that now requires Mode C transponders.

ADS-B In is the ability of an aircraft to receive information from other aircraft transmitting data and from the ATC ground infrastructure. In addition to location data, it will provide pilots with traffic and weather information. Traffic information will be similar to that received from the current TIS (Traffic Information System), TAS (Traffic Advisory System), and TCAS (Traffic Collision Avoidance System) systems in use today.

Weather information will be similar to the current XM Weather, except that it will be customized to the aircraft's geographic location, and it will not require a subscription. The information will be free to anyone who chooses to equip their aircraft with certified ADS-B-In capability. At this time, ADS-B In will be optional for most aircraft.

The FAA worked with the ICAO (International Civil Aviation Organization), CANSO (Civil Air Navigation Service Organization), and other agencies from governments around the world to develop standards to equip aircraft capable of worldwide travel. A Mode S transponder with ES (Extended Squitter) is required and is already mandated in parts of Europe. The specific guidance from the European

Commission's SES (Single Sky Committee) approved the SPI-IR (Surveillance and Performance Interoperability Implementing Rule), identifying surveillance system performance and ground and airborne interoperability requirements for ADS-B in Europe. The mandate for ADS-B in Europe was for forward-fit aircraft to be equipped on all aircraft after June 2016 and retrofit was required by June 2020. These provisions applied to aircraft with an MTOW (maximum takeoff weight) of more than 12,566 pounds (5,700 kg) or with a cruising speed of more than 250 knots, including those operated by carriers around the world.

Please refer to Duncan Aviation's ADS-B Straight Talk Book for additional information on ADS-B In and Out.

RNAV/RNP

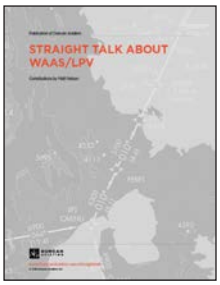
Both RNAV (Area Navigation) and RNP (Required Navigation Performance) are types of navigation that allow an aircraft to fly a specific path between two points in space. The main difference between the two is that the RNP specification for the on-board navigation equipment requires performance monitoring and alerting.

You will often see a number following the RNP acronym; for example, RNP 10. This means that the navigation system must have the performance ability to provide position calculations within a circle that has a radius of 10 nautical miles. Another common example is RNP .1. Now with the popularity of highly accurate WAAS (Wide Area Augmentation System) GPS, RNP .1 means that the navigation system can calculate its position to within a circle with a radius of one-tenth of a nautical mile.

In an oceanic airspace, an RNP value of 4 vs. 10 will allow the aircraft with the lower RNP-valued system to maintain a closer separation between other aircraft. On approaches, aircraft with capable equipment and RNP values down to .1 can allow very precise 3D curved flight paths known as SAAAR (Special Aircraft and Authorization Required) or RNP AR (Authorization Required). Approvals for this operation are rare due to the limited number of approaches and strict requirements. Watch for this to gain popularity in the next decade.

WAAS

In 2007, the FAA completed and certified a significant upgrade to the GPS system. This new system, dubbed WAAS (Wide Area Augmentation System), uses a network of more than 25 precision



www.DuncanAviation.aero/resources/straight-talk/waas-lpv

ground stations to provide corrections to the GPS navigation signal. The network of surveyed ground reference stations that collect GPS satellite data is strategically positioned around North America in places that include Alaska, Hawaii, Puerto Rico, Canada, and Mexico. This error-correction information is then broadcast as a message, correcting any signal errors. These correction messages are broadcast through communication satellites to an aircraft's airborne GPS receiver using the same frequency as GPS.

WAAS is designed to provide the accuracy, availability, and integrity necessary to allow flight crews to rely on GPS for all phases of flight, from en-route through GPS precision approaches for all qualified airports within the WAAS coverage area. Through WAAS, airports can develop more guidance for standardized precision approaches, missed approaches, and departures for thousands of runways and hundreds of heliport/helipads in the US airspace.

At the time of this publication, there are more than twice as many airports with WAAS approaches than ILS (Instrument Landing System) approaches in the United Sates (totaling 3613). WAAS will also provide increased accuracy in position reporting, allowing for more uniform and high-quality worldwide air traffic management. WAAS is a critical part of the FAA's NextGen program.

The current advantages of WAAS/LPV are that it lets operators plan more fuel-efficient routes and approaches that have reduced minimums. WAAS-approved units also incorporate necessary RNP/RNAV to take advantage of preferential flight routing such as PBR (Performance Based Routing).

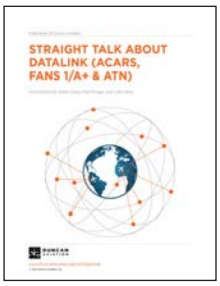
Please refer to Duncan Aviation's WAAS Straight Talk Book for additional information on the subjects of RNAV/RNP and WAAS.

DATALINK

ACARS or Aircraft Communications, Addressing, and Reporting System, is a digital information service designed to transmit digital data messages between aircraft and ground stations. It was designed by ARINC in the late 1970s to help reduce crew and ATC workloads. The aircraft portion of legacy ACARS was an AFIS DMU (Aerodrome Flight Information Service/Data Management Unit) or UNILINK, FMS (Flight Management System), and VHF/HF radio or Satcom system. Supported applications include:

- PDC (Pre-Departure Clearance)*
- OCL (Obstacle Clearance Limit)
- TWIP (Terminal Weather Information for Pilots)

**The difference between PDC and DCL is that PDC can be delivered to the aircraft by several means (printed on paper, via the internet, from the airline, or via ACARS), while DCL is a direct connection from ATC only delivered to the aircraft via the datalink on a FANS-1/A+ or ATN-capable aircraft*



www.DuncanAviation.aero/resources/straight-talk/datalink-acars-fans-1-a-atn

FANS (Future Air Navigation System) is an initiative begun in the early 1980s by the ICAO. ICAO was concerned about the aging infrastructure and the inherent faults with traditional air-traffic-management methods. In an effort to increase aircraft safety and limit human error, ICAO developed a council to investigate ways to increase safety. The FANS concept for future air traffic management uses digital CNSes (Communications and Navigation Systems), including GPS and surveillance improvements. The combination of improvements in communication, navigation, and surveillance allow authorities to reduce separation distance between aircraft, allowing aircraft to fly at their most favorable altitudes and consume less fuel.

There are 2 major components to FANS:

1. CPDLC (Controller Pilot Data Link Communication) is a means of communication between a controller and a pilot using a datalink. CPDLC is like texting; ATC and the flight crews exchange text-based messages instead of voice communications that are currently used in the flight decks. The CPDLC application has three primary functions:

   - Digital exchange of messages between the pilot and the ATC who is currently in control of the aircraft
   - Easy transfer of the authority over that aircraft from one controller to another
   - Future ATC authority (downstream) for clearance delivery, or the approval of other ATCs in adjacent centers to view the aircraft reports

2. ADS-C (Automatic Dependent Surveillance-Contract). Automatic position reports are known as ADS-C and require no pilot action. The contract in ADS-C means that ATC will control the reporting system. There can be up to five ATC contracts at any time.

There are three types of contracts always present:

- **Periodic.** ATC can set or alter the update rate as needed. A higher update rate is usually required in high traffic areas
- **Event.** ATC contracts are used if there is a change in Vertical Rate, Lateral Deviation, or Altitude
- **Demand.** ATC can request a one-off update as needed. This does not affect an existing contract preset rate

There is a fourth type of contract, but unlike the previous three, it is initiated and canceled by the pilot, not the controller. Emergency is the fifth contract, and it is automatically triggered by a MAYDAY message.

As with RVSM (Reduced Vertical Separation Minimum), the goal of ADS-C is to reduce separation among aircraft. ADS-C is expected to reduce separation from 100nm (nautical miles) laterally and 10 minutes trailing to 50nm longitudinal, 30nm laterally and 30nm trailing.

ATN-B1 (Aeronautical Telecommunications Network-Baseline-1)—ATN-B1 (PM CPDLC and Link 2000+) is the ICAO engineering designation for this technology standard.

ATN-B1 is a datalink service that consists of the following:

- **(CM) application.** Context management
- **CPDLC.** Controller Pilot Data Link Communications for ATC communications

Although ATN-B1 is similar to the FANS/CPDLC system used in North Atlantic airspace, ATN-B1 uses a VHF VDL Mode 2 radio instead of a Satcom. It is meant to be used in areas where ground surveillance already exists because there is no surveillance component to this technology.

ATN-B2 (Aeronautical Telecommunications Network-Baseline 2)—ATN-B2 (Data Comm) will enable additional capabilities not incorporated in FANS-1/A+ or ATN-B1. ATN-B2 CPDLC will include context management, CPDLC, and ADS-C over the IP (Internet Protocol) suite. B2 provides additional services for both CPDLC and ADS-C. This program is being rolled out in two segments:

Segment 1, Phase 1 allows for tower services DCL (Departure Clearances) to be obtained via CPDLC at all airports that

currently support FANS-1A+ technology. In 2016, the FAA rolled out DCL Data Comm services at 55 US airports.

Segment 1, Phase 2 rollout allows for initial en-route services of CPDLC.

- Transfer of communications
- Initial check-in
- Altimeter settings
- Altitudes
- Speed
- Crossing restrictions
- Airborne reroutes
- Controller initiated reroutes
- Direct to fix

Segment 2 will allow for more advanced or full en-route services and technologies.

- Controller-initiated routes
- Crossing restrictions
- Direct to fix
- Advisory messages
- Holding instructions

Please refer to Duncan Aviation's Datalink Straight Talk Book for additional information on this subject.

INTERNATIONAL IMPLEMENTATION

NextGen is a US-based initiative; however, Europe has been running a parallel initiative called SESAR (Single European Sky ATM Research). The goals are nearly identical, and in 2010, the United States and European authorities reached initial agreements on the interoperability between their future air traffic management systems.

European nations and other countries around the world are looking to implement similar systems. Referenced below are the NextGen systems from the US with the equivalent or similar systems from Europe.

ADS-B—Automatic Dependent Surveillance Broadcast (Out and In). In Europe, the terminologies are essentially the same.

RNAV/RNP—Types of Performance Based Navigation, Area Navigation/ Required Navigation Performance, including IAP (Instrument Approach Procedures). B-RNAV (Basic–RNAV) defines European RNAV operations and satisfies the requirement for a track that maintains accuracy of plus or minus 5nm for at least 95% of the flight time. P-RNAV (Precision RNAV) defines European RNAV operations where waypoints are located below MSA (Minimum Sector Altitude) or MRVA (Minimum Radar Vectoring Altitudes).

WAAS—Wide Area Augmentation System with LPV (Localizer Performance with Vertical Guidance) approach procedures. Throughout Europe, the system is known as EGNOS.

EGNOS—European Geostationary Navigation Overlay Service is the European system. Like WAAS, EGNOS augments the GPS, GLONASS, and Galileo satellite systems by reporting on the reliability and accuracy of the position data.

FANS—Future Air Navigation System. In Europe, the terminologies are essentially the same.

ATN-B1 (CPDLC). In Europe, as of January 28, 2021, in order to be able to use ATN-B1 in specific areas of EASA airspace (France, Switzerland, Maastricht-Upper Airspace Command), each aircraft must go to the Logon List Dashboard maintained by OneSky, and the operator must enter the requested aircraft-specific equipment to get approval to operate ATN-B1 in those regions

- Before you can access the dashboard, you must first have an account with OneSky. The reason for the Logon List is the high rate of provider aborts at the initial rollout of the ATN-B1 mandate. The Logon list also provides a list of proven equipment that meets the requirements.

CONCLUSION

The FAA's NextGen initiatives take advantage of today's precise and accurate digital technologies to ensure the safety and reliability of air transportation. Air traffic has been increasing noticeably over the last decade, and the systems being implemented are needed to accommodate the growing demands on our national airspace

and infrastructure. As mentioned, the FAA has been working with its global counterparts to ensure that NextGen is compatible with current and future worldwide airspace requirements.

As these goals become a reality at more and more airports, you'll see a phrase we've often repeated put into greater practice: Best equipped, best served. This means that those owner/operators who've complied with mandates and upgraded to the latest technologies will eventually be given priority over those who have not.

NEXTGEN FAQS

Will I receive preferential treatment if I adopt all or some NextGen initiatives?
Yes. ATC intends to provide best-equipped, best-served priority in the national air space to owners/operators who adopt the initiatives consistent with safe and efficient operations.

Does Europe have a similar *umbrella* traffic management plan?
Yes. Europe is implementing the SES (Single European Sky) initiative. The SESAR (Single European Sky Air Traffic Management Research) technical planning group consists of members from EASA (European Aviation Safety Agency), the EU (European Commission), and Eurocontrol.

Do the NextGen and SES plans have the same subcomponent parts?
NextGen and SES are not identical due to air traffic differences between Europe and the US. Restricted airspace over the individual sovereign countries has created high concentrations of air traffic indirect routing within established FABs (Functional Airspace Blocks). A significant part of the SES initiative is to reduce and enlarge the FABs to create more direct routing and reduce congestion. Another unique SES component is the adoption of TCAS 7.1, which was prompted by mishaps in European airspace that have highlighted the need for more advanced traffic avoidance equipment. Other NextGen/SES initiatives, however, are similar in that they are built around performance-based navigation.

How will NextGen components be implemented without disrupting air-traffic-management services?
NextGen capabilities will come online gradually, and a cautious approach will be exercised to avoid disruptions in air traffic control.

What are the chief benefits of NextGen?
The advantages of NextGen are:

- Increased safety. Advanced systems both in the aircraft and in the control tower
- Reduced emissions. Moving aircraft to their destinations sooner and more efficiently
- Reduced delays. Improvements in aircraft systems and traffic management
- Reduced airport congestion. Improvements in ground tracking and traffic management
- Reduced fuel use. Moving aircraft to their destinations sooner and more efficiently

Which, if any, NextGen initiatives will be mandated?
At the time of this publication, ADS-B Out was mandated by the FAA by Jan 1, 2020 and by EASA by June 8, 2020. In addition, FANS-1A is mandated for the entire NAS airspace as of 2020. Contact a Duncan Aviation expert for the most up-to-date mandate information regarding NextGen:
www.DuncanAviation.aero/services/avionics-installation/contacts

What can I do now to incorporate NextGen components in my aircraft?
Duncan Aviation holds and has access to dozens of STCs (Supplemental Type Certificates) to upgrade your aircraft so it's in compliance with the NextGen requirements. FANS 1/A installations and TCAS 7.1 are available via an STC.

A comprehensive matrix is available on the Duncan Aviation NextGen website showing ADS-B compliance:
www.DuncanAviation.aero/services/avionics-installation/nextgen

Most part 23 and Part 25 aircraft will be covered under this matrix. If you would like more information and a quote, please have your equipment list or Chapter 34 of your maintenance records available as this will be necessary to give you an accurate quote.

KEY TERMS

1090MHz ES (Extended Squitter)—is datalink that uses a 1090MHz (megahertz) ES that supports ADS-B but not FIS-B. It's intended for use in air carrier, business, and other high-performance aircraft. This link is capable of using an existing Mode S transponder with specific modifications.

978MHz UAT (Universal Access Transceiver)—is datalink that supports ADS-B as well as TIS-B and FIS-B for use in airspace below 18,000 feet.

ADS-B (Automatic Dependent Surveillance-Broadcast)—is a cooperative system that transmits position and flight profile information to ATC (air traffic control).

ASDE-X (Airport Surface Detection Equipment, Model X)—A runway safety tool that provides detailed coverage of movement on runways and taxiways so traffic controllers can detect potential runway conflicts.

B-RNAV (Basic RNAV)—defines European RNAV operations that satisfy a required track keeping accuracy of ± 5nm (nautical miles) for at least 95% of the flight time.

CANSO (Civil Air Navigation Service Organization)—is the global voice of the companies that provide air traffic control and represents the interests of ANSPs (Air Navigation Service Providers) worldwide. CANSO members are responsible for supporting more than 85% of world's air traffic, and through its workgroups, members share information and develop new policies with the ultimate aim of improving air navigation services on the ground and in the air. CANSO has an extensive network of Associate Members drawn from across the aviation industry, and it represents CANSO members' views in major regulatory and industry forums, including at the ICAO, where it has official observer status.

CDA (Continuous Descent Approach)—Known as OPD (Optimized Profile Descent) in the US, CDA involves maintaining a constant 3^0 angle of descent during landing instead of approaching an airport in a stair-step.

CDTI (Cockpit Display of Traffic Information)—is a standalone or integrated display that provides an aircraft crew with detailed information about other aircraft, specifically spacing intervals.

CPDLC (Controller Pilot Data Link Communication)—is a datalink application that lets an air traffic controller and a pilot exchange text-based messages.

EGNOS (European Geostationary Navigation Overlay Service)—is an SBAS (satellite-based augmentation system) developed by the European Space Agency, the European Commission, and EUROCONTROL. It supplements the GPS GLONASS and Galileo systems by reporting on the reliability and accuracy of the signals. The EGNOS system consists of three geostationary satellites and a network of ground stations.

ERAM (En Route Automation Modernization)—New software that allows the aircraft to file the most direct route from departure to destination and make in-flight route changes quickly and efficiently.

FANS 1/A (Future Air Navigation System)—is a NextGen, total air-traffic system that includes communication, navigation, and monitoring functions. Its purpose is to cope with the increasing volume of air traffic and provide more effective navigation.

FIS-B (Flight Information Services Broadcast)—is a system that provides weather text and graphics, NOTAM (Notice to Airman), ATIS (Automatic Terminal Information Service), and other information over the Universal Access Transceiver link.

GAGAN (GPS Aided Geo Augmented Navigation or GPS and Geo Augmented Navigation)—is an SBAS (Satellite Based Augmentation System) used by India. It is a system to improve the accuracy of a GNSS (Global Navigation Satellite System) receiver by providing reference signals.

GBAS (Ground Based Augmentation System)—is a system that supports regional augmentation through the use of terrestrial radio messages.

ICAO (International Civil Aviation Organization)—is a specialized agency of the United Nations. It codifies the principles and techniques of international air navigation and fosters the planning and development of international civil aviation to ensure safe and orderly growth. It is headquartered in Canada.

Link 2000+—is a Eurocontrol program that coordinates dates and standards for implementing CPDLC in Europe. Link 2000+ is similar to the FANS CPDLC system used in North Atlantic airspace. The difference being Link 2000+ uses VDL Mode 2 datalink and ATN (Aeronautical Telecommunications Network) instead of ACARS.

PBN (Performance Based Routing)—is a framework for defining performance requirements in navigation specifications. PBN framework can be applied to an air traffic route, instrument procedure, or defined airspace. PBN provides a basis for the design and implementation of automated flight paths as well as for airspace design and obstacle clearance. The two main components of PBN framework are RNAV (Area Navigation) and RNP (Required Navigation Performance). Once the required performance level is established, the aircraft's own capability determines whether it can safely achieve the specified performance and qualify for the operation.

P-RNAV (Precision RNAV)—defines European RNAV operations that satisfy a required track-keeping accuracy of ±1nm for at least 95% of the flight time. The waypoints are located below MSA or MRVA (minimum radar vectoring altitudes).

PSR (Primary Surveillance Radar)—is a ground-based radar system that measures distance and bearing to an aircraft based solely on radar reflection.

RNP (Required Navigation Performance)—is a type of performance-based navigation that lets aircraft fly a specific route between two 3D defined points in space.

RNP-AR (Required Navigation Performance-Authorization Required) a.k.a RNP SAAAR (Required Navigation Performance Special Aircraft and Aircrew Authorization Required)—enables aircraft to fly very precise, curved path approaches with lower minimums at airports with challenging airspace and/or terrain. In order for operators to use RNP-AR, an approval process similar to ILS CAT II/III approval is required.

RVSM (Reduced Vertical Separation Minimum)—is a minimum vertical separation requirement between aircraft above flight level 290 (29,000ft), from 2,000ft-to-1,000ft. RVSM was implemented to increase airspace capacity, by essentially doubling the number of flight levels between 29,000 and 41,000ft.

Planes must have certified altimeters and autopilots must meet more accurate standards to operate in RVSM airspace.

SBAS (Satellite Based Augmentation System)—is a system that supports wide-area or regional augmentation through the use of satellite messages.

SESAR (Single European Sky ATM Research)—The European Union's SES is an ambitious initiative launched by the European Commission in 2004 to reform the architecture of European air traffic management. It proposes a legislative approach to meet future capacity and safety needs at a European rather than a local level. SES is the only way to provide a uniform and high level of safety and efficiency over Europe's skies.

SPI-IR (Surveillance and Performance Interoperability Implementing Rule)—specifies the requirements for the European Air Traffic Management Network and how new surveillance technologies and applications will be introduced to Europe's Air Traffic Management system. The aircraft identification rule will require air navigation service providers (ANSPs) to use down-linked aircraft identification for identifying aircraft, without having to rely solely on Secondary Surveillance Radar codes.

SSR (Secondary Surveillance Radar)—is a ground-based system which makes use of an aircraft's transponder(s) to relay the following information: a four-digit identification code (Mode A), altitude (Mode C), a unique identifier (Mode S), a flight identification number (Elementary Surveillance), and more detailed position and trajectory data (Enhanced Surveillance). It supplements PSR, giving Air Traffic Control more information.

TCAS (Traffic Collision Avoidance System) version 7.1—TCAS version 7.1 will be offered as an upgrade by all of the major TCAS manufacturers and also makes two important safety enhancements. Version 7.1 changes the current TCAS II aural warning from *Adjust Vertical Speed, Adjust to Level Off, Level Off*. It also corrects missed and late TCAS reversals. TCAS reversals were introduced in TCAS version 7.0 to adapt to changing situations where the original sense had clearly become the wrong thing to do, in particular the situation when one of the pilots decides not to follow the RA (Resolution Advisory) or is instructed by ATC to perform a particular maneuver. The solution in Version 7.1

introduces improvements to the current reversal logic to address late issuance of reversal RAs and potential failures to initiate reversal RAs.

TIS-B (Traffic Information Services)—is a system which transmits traffic known to the ground-based ATC system to an aircraft. This fills the gap for aircraft equipped with transponders but not ADS-B.

WAAS (Wide Area Augmentation System)—is a system developed to augment GPS, with the goal of improving its accuracy, integrity, and availability. It is intended to enable aircraft to rely on GPS for all phases of flight, including precision approaches to any airport within its coverage area.

Wide Area Multilateration (WAM)—Multilateration is the method of determining a target's position from the TDOA (Time Difference of Arrival) of transponder replies at spatially separate receivers. With Wide Area Multilateration, the receivers are spread much further apart.