What is GBAS and its goal in the National Airspace System?

A Ground Based Augmentation System (GBAS) augments the existing Global Positioning System (GPS) utilized in U.S. airspace by providing corrections to aircraft in the vicinity of an airport in order to improve the accuracy of, and provide integrity for, these aircrafts’ GPS navigational position. The goal of GBAS implementation is to provide an alternative to the Instrument Landing System (ILS) supporting the full range of approach and landing operations. Current non-federal (non-Fed) GBAS installations provide Category I (CAT-I) precision approach service. The Federal Aviation Administration (FAA) work program is now focused on validating standards for a GBAS Approach Service Type-D (GAST-D) (CAT-III minima) service. The program currently projects a GAST-D GBAS system can be available in 2018.

What are the benefits of GBAS?

GBAS has several advantages in comparison to traditional ILS. One GBAS station can support multiple runway ends and reduce the total number of systems at an airport. This reduces the Very High Frequency (VHF) requirements and simplifies airport infrastructure. Unlike ILS — which requires one frequency per system — a GBAS only requires one VHF assignment for up to 48 individual approach procedures. The GBAS has more flexible siting criteria, allowing the GBAS to serve runways which ILS is unable to support. A GBAS is sited to minimize critical areas which place fewer restrictions on aircraft movement during ground taxi and air operations. The GBAS approach guidance is steadier than ILS approach guidance. Also, GBAS requires less frequent flight inspections compared to those required of ILS systems.

Are any GBAS systems approved for Precision Approach operations?

Yes, the SLS-4000 supports CAT-I Precision Approach operations. The Honeywell International SLS-4000 SmartPath® Landing System received System Design Approval (SDA) from the FAA in September 2009. Honeywell developed an upgrade which improves operation when exposed to radio frequency interference; this received FAA SDA in September 2012.

Where are operational GBAS systems located?

Currently, two U.S. locations have obtained operational approval for public GBAS use and support revenue airline traffic. These stations are located at Newark Liberty International Airport (EWR) and Houston George Bush Intercontinental Airport (IAH). Internationally, several airports have GBAS and support revenue operations (Bremen and Frankfurt, Germany; Sydney, Australia; Malaga, Spain; Zurich, Switzerland; and 15 Russian locations).
What is LAAS?

GBAS is an International Civil Aviation Organization (ICAO) standardized system for local area differential systems. The U.S. version of GBAS was initially referred to as the Local Area Augmentation System (LAAS). Several historical FAA documents still retain the LAAS terminology. While the terms are synonymous, the FAA has migrated to the ICAO term GBAS.

What is GNSS?

Global Navigation Satellite System (GNSS) is a worldwide position, navigation, and time determination system which includes one or more satellite constellations, aircraft receivers, and system integrity monitoring augmented as necessary to support the required navigation performance for the intended operation. The key word is “Global” vice “Regional” navigation systems. Core global navigation constellations in GNSS are the U.S. GPS and the Russian Global Navigation Satellite System (GLONASS). Two additional global systems are in varying stages of development and fielding: the European Galileo system and Chinese BeiDou system.

What equipment does a GBAS have?

A GBAS ground facility typically has three or more GPS antennas, a central processing system (i.e., a computer), and a VHF Data Broadcast (VDB) transmitter all locally situated on or near an airport. GBAS airborne equipment consists of GPS antenna(s), a VHF antenna, and associated processing equipment. Multi-Mode Receiver (MMR) technology allows simultaneous implementation of GPS, GBAS and ILS using common antennas and hardware. The GBAS uses the VHF radio link to provide aircraft with GPS corrections, integrity, and approach path information. More information about how GBAS works is available on the FAA Navigation Services – GBAS – How It Works web page link:

http://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/techops/navservices/gnss/laas/howitworks/

What is GAST-C and GAST-D?

The GBAS Approach Service Type (GAST) is a nomenclature which describes the level of service provided by a specific GBAS facility. GAST-C and GAST-D define requirements based on single-frequency augmentation. GAST-C is intended to support precision approach operations in CAT-I minima and GAST-D for CAT-III minima. Note, a combination of factors determines the flight minimums authorized for a specific approach and aircraft.

Is there future GBAS developmental work planned or anticipated?

Yes. The FAA and other States are in the process of validating proposed ICAO GBAS standards to support Category III (CAT-III) precision approach operations. The FAA expects ICAO will approve GAST-D Standards and Recommended Practices in 2015. In the meantime, the FAA
has already provided System Design Approval for GBAS capable of providing CAT-I precision approach operations.

**What is a Federal System versus a non-Federal system?**

Throughout the National Airspace System, you will find a mixture of Federal and non-Fed navigational aids. The Federal systems are paid for and maintained by the FAA. However, some airports, cities, and/or private entities may purchase and maintain a navigational aid for either private or public use. These navigational aids are known as non-Fed systems because the FAA did not purchase them, nor does the FAA maintain them. However, to ensure public safety, the FAA does retain the power to approve or not approve these non-Fed systems; additionally, they inspect them annually.

**What is GLS?**

According to FAA Order 8260.19, *Flight Procedures and Airspace GBAS Landing System (GLS)* is the FAA’s official term for a GBAS instrument approach procedure. The term GLS appears on every GBAS approach chart.

**What is the difference between GBAS and GLS?**

GBAS is the name of the navigation system which provides precision GBAS corrections from a ground-based transmitter. GBAS corrections can provide position, navigation, and precision approach services. GLS is the name assigned to the instrument approach procedure/capability provided by GBAS.

**Is the FAA collaborating with airlines and industry on the GBAS development effort?**

Yes. The FAA has agreements with United Airlines, the Port Authority of New York and New Jersey, Houston Airport System, and Boeing to gain operational experience with the existing GBAS systems. The knowledge gained from these operational systems is helping the FAA better define the CAT-III GBAS system and provide realistic operational costs and benefits which will be used to make future decisions regarding CAT-III GBAS acquisition.

**Are there any prototype GBAS systems still in use?**

Yes, but the number is very limited. In the beginning stages of GBAS development, the FAA worked in collaboration with industry partners on a number of prototype systems. Some of these prototype systems have been refurbished to the new design and deployed. For example, a system initially installed in Memphis was refurbished and installed in Houston as an operational system. The prototype system deployed at the FAA William J. Hughes Technical Center remains a test system and supports validation of the CAT-III requirements. Other prototype systems were installed at U.S. airports including those in Guam, Chicago, Seattle, and Minneapolis. These prototypes have not been refurbished and are not in operational use at this time.
Are there other installed GBAS systems?

Yes. Some private companies have installed systems for use in the development and certification of aircraft and avionics (e.g., the Honeywell test facility at Olathe, Kansas). In some cases, the private companies have obtained FAA operational approval for Instrument Flight Rules operations to CAT-I decision heights. The Boeing Company at Moses Lake, in Washington State is an example of such an installation.

Will more SLS-4000 systems be fielded?

The SLS-4000 CAT-I system is currently available for purchase and installation by airport authorities as a non-Fed navigation aid. The FAA does not plan to procure any CAT-I SLS-4000 systems. The FAA has a CAT-III GBAS Research and Development Project underway, but it currently has no plans to develop or field any federal GBAS facilities.

Can airports purchase a GBAS?

Yes. Anyone can purchase and install an approved non-Fed GBAS CAT-I system. However, if the system owner wants to use the system in the NAS under instrument meteorological conditions (IMC), the owner must follow FAA guidance and evaluation on siting, GLS procedure development, installation approval and final flight inspection of the station and each GLS procedure. After final approval, the GBAS station would be subject to annual non-Fed ground inspections and periodic flight inspections just like any other navigational aid serving in the NAS.

Are there special requirements and associated certifications needed related to the installation of a GBAS at an airport?

Yes. GBAS has some siting, licensing, and certification requirements. GBAS has more flexible siting requirements than ILS in that it is not aligned to a specific runway. Manufacturer guidance and FAA Order 6884.1, Siting Criteria for GBAS, identify specific siting requirements. GBAS requires a Federal Communications Commission license and frequency assignment for the VDB transmitter, as well as a Site Acceptance Test, a Flight Check, and non-Fed approval. These requirements are similar to ILS.

What aircraft have GBAS equipage?

GBAS is available on many new transport aircraft models. GBAS equipage is standard on Boeing 747-8 and Boeing 787 aircraft. GBAS is an option on Boeing 737-Next Generation (737-600/-700/-800/-900), Airbus A320, A330/340, A350 and A380 aircraft.

Are airlines using GBAS?

Yes. Many airlines have operational approval to fly GLS in the United States (United Airlines, Delta Airlines, British Airways, Emirates Airlines, Lufthansa, and Cathay Pacific). Additional
airlines fly GLS internationally (Qantas, TUIfly, Swiss Air, Air Berlin and various Russian airlines).

**What GBAS avionics are available?**

At least two manufactures have FAA approved GBAS avionics. These are Rockwell Collins’ (Multi-Mode Receiver (MMR) GNLU 925 and GNLU 930 and Honeywell International’s Integrated Navigation Receiver (INR). The FAA’s Technical Standard Order (TSO) C161a, Ground Based Augmentation System Positioning and Navigation Equipment, provides approval criteria for the GBAS avionics navigation function, while TSO-C162a, Ground Based Augmentation System Very High Frequency Data Broadcast Equipment provides the approval criteria for the data link equipment.

**Can GBAS support Category II/III Precision Approach operations?**

Individual States are currently validating the requirements. In the U.S., the FAA has undertaken a GBAS CAT-III Research and Development effort to validate the proposed ICAO GBAS CAT-III requirements.

**When will a GBAS Category II/III system be available?**

ICAO should approve Standards and Recommended Practices for GBAS Category II/III (GAST-D) systems in 2015. The availability of GBAS CAT-III systems will depend on manufacturer desire to develop the equipment and seek System Design Approval which will depend on customer orders and demand.

**What is the FAA plan for GBAS?**

The FAA continues to validate the GBAS CAT-III requirements as part of the Next Generation Air Transportation System (commonly known as NextGen). The FAA has currently deferred any Federal acquisition decision on GBAS.

**How is GBAS different than WAAS?**

GBAS and Wide Area Augmentation System (WAAS) are both GPS augmentation systems. However, GBAS and WAAS differ in approach and infrastructure, resulting in different capabilities. WAAS uses a network of spatially separated reference stations to make multiple simultaneous measurements of GPS satellites. The multiple simultaneous measurements support the calculation of individual correction of ephemeris (orbit), clock, and ionosphere delay. The corrections are broadcast by a geostationary satellite using the L1 frequency, enabling the use of the same GPS antenna to receive the corrections. GBAS makes GPS measurements at the local airport it serves and averages measurements from multiple antennas to minimize the potential error. GBAS broadcasts the GPS corrections using a VHF data link to the region around the airport, resulting in timely receipt of sufficiently accurate corrections potentially good enough to support operations to CAT-III minima.
Can the same avionics be used for GBAS and WAAS?

The GBAS and WAAS standards are different and initial avionics and integrations only supported one of the two capabilities. Emerging aircraft integrations can support both services (e.g. A350).

How do conditions within the GPS constellation affect GBAS availability?

The availability and continuity of GLS approaches can be impacted by the state of the GPS constellation. Maintenance or maneuvers of satellites, which are generally forecasted in public Notice to Navigation System with Timing and Ranging (NAVSTAR) Users (NANUs), can diminish the nominal constellation to a level which will not allow a GBAS to meet the integrity required for a precision approach. Many of these interruptions in service are predictable based on the posted NANUs and the repeatable nature of the GPS constellation at a given time each day. Predicted outages for the current operational GBAS installations at Newark Liberty International Airport (EWR) and Houston George Bush Intercontinental Airport (IAH) are forecasted by the FAA’s GBAS Service Prediction Tool, which was developed and maintained by the FAA’s Engineering Development Services Division, Navigation Branch, ANG-C32. GBAS sponsors [currently the Port Authority of New York and New Jersey (PANYNJ) and Houston Airport System (HAS)] are required to issue a Notice to Airmen (NOTAM) for these outages. A subscription to daily predicted outage notices for these sites is available at http://laas.tc.faa.gov/PredictedOutages.html. The FAA does not plan to provide this service prediction tool for future GBAS sites. This requirement will have to be met by GBAS sponsors by other means, possibly including modification of the Honeywell International SLS-4000 SmartPath® Landing System to generate service predictions internally.

Where can I find a concise and high-level handout that provides information about GBAS?

Please see our GBAS fact sheet on the faa.gov web page link:


The Ground Based Augmentation System (GBAS) program is managed by the FAA’s Engineering Development Services Division, Navigation Branch and ANG-C32 at the FAA William J. Hughes Technical Center. More information can be found at http://laas.tc.faa.gov/.