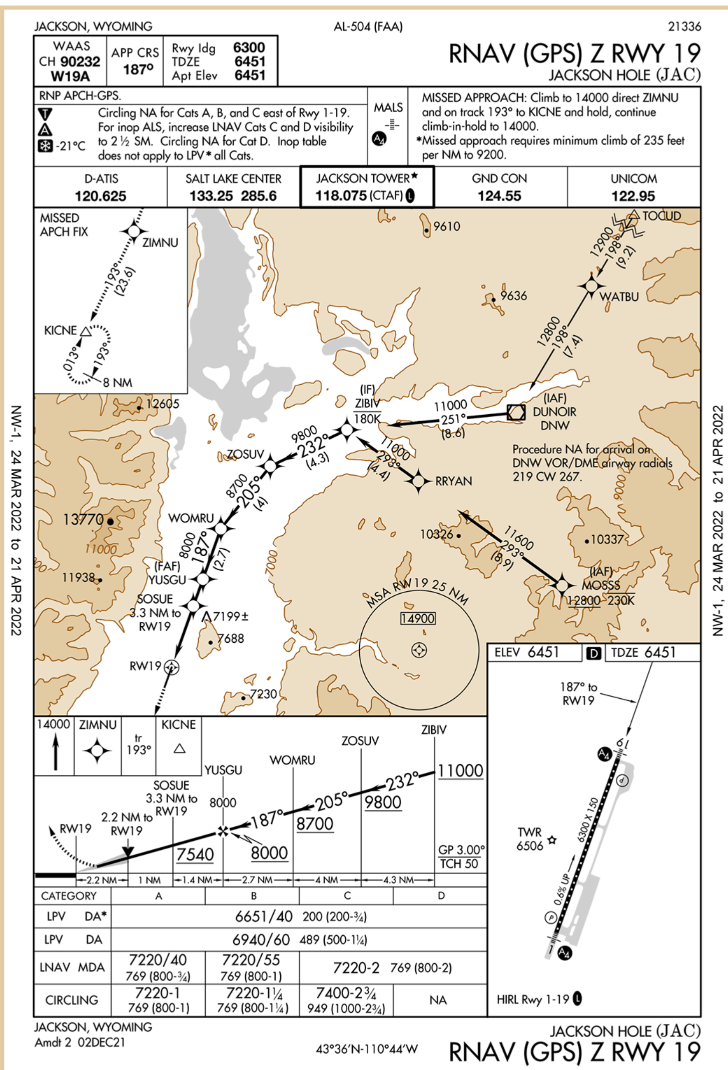
SBAS Worldwide

A Satellite Based Augmentation System (SBAS) is a navigation system that supplements the Global Navigation Satellite System (GNSS) providing a more accurate and reliable navigation service than GNSS alone.

SBAS Benefits

SBAS provides a more accurate navigation service than basic GPS-RAIM systems and also provides the high level of integrity required for most aviation navigation operations. Several interoperable SBAS' have been or are being implemented around the world due to the benefits they provide.

SBAS technology provides the opportunity to cover very large areas of airspace and areas formerly under-served by navigation aids. It also adds increased capability, flexibility, and in many cases, more cost-effective navigation options than legacy ground-based navigation aids. SBAS is a key enabler of Performance Based Navigation (PBN).



Approach Capability

SBAS enables Required Navigation Performance (RNP) 3D approaches to Localizer Performance with Vertical guidance (LPV) lines of minima. RNP 3D approaches to LPV minima are functionally equivalent to Category 1 precision approaches but require less airport infrastructure. Specifically, RNP approaches do not require the installation or maintenance of Instrument Landing Systems (ILS) for each runway since the navigation service is provided to the aircraft entirely by satellites.

- **United States:** As of June 12, 2025, there are 4,205 published LPVs serving 2,031 airports. The Federal Aviation Administration (FAA) continues to add LPVs to qualified runways.
- **Canada:** As of June 12, 2025, there are 865 LPVs published with plans for more to follow.
- **Europe:** As of October 3, 2024, there are 859 operational LPVs with plans for more to follow.
- **Japan:** Has started LPV trial operations of 13 procedures with plans for use in 2024.
- **India:** As of September 2023, there are 8 published LPVs serving 5 airports. An additional 16 LPVs are in progress.

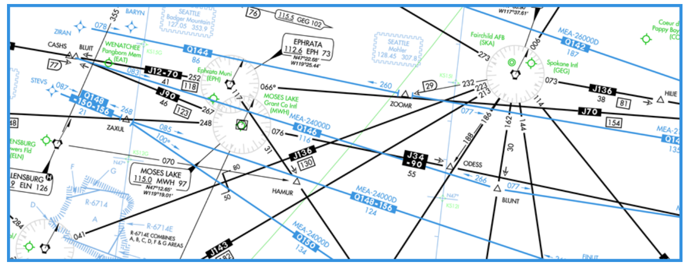
RNP 2D approach to Localizer performance (LP) minima is another type of SBAS-enabled approach procedure that made its debut in January 2011. LPs provide approach capability to runways unsuitable for vertically guided approaches. They provide the lateral accuracy, integrity, and reliability of a LPV without the vertical guidance, similar to a localizer only approach. As of June 12, 2025, there are 750 published LPs in the US, serving 543 airports.

A Point-in-Space (PinS) approach is a helicopter-specific maneuver adapted to helicopter flight envelopes and landing sites. Thus, a PinS LPV enabled by SBAS improves the resilience of air ambulances and Helicopter Emergency Medical Services (HEMS) when they need to land, for example, at a hospital helideck. Numerous PinS approaches are in use in the US, with many implementations on-going in Europe.

En Route Capability

For en route navigation guidance, SBAS includes integrity as a part of its service and eliminates the need for GPS Receiver Autonomous Integrity Monitoring (RAIM) checks.

Direct routes improve airspace capacity and relieve congestion while reducing fuel use and pollution. By eliminating the need for airways to be tied to ground-based navigation aids, SBAS-equipped aircraft gain the flexibility and benefit of point-to-point operations.



In the United States, SBAS satisfies equipment requirements for the new, more direct en route flight options of 'T' and 'Q' routes.

- T-Route: an Area Navigation (RNAV) route used in low-altitude airspace operating below 18,000 feet.

SBAS around the World

SBAS was born for aviation and began with the implementation of the Wide Area Augmentation System (WAAS) in the United States (US). Today, SBAS is available in many parts of the world and current SBAS service coverage is provided by a collection of interoperable systems. Worldwide SBAS coverage is continuing to grow.

Wide Area Augmentation System (WAAS)

- Commissioned in July 2003 (http://gps.faa.gov)
- Serves North America, with benefits that extend into Central and South America and over the Atlantic and Pacific oceans
- Developing a Dual-frequency service - 2027

European Geostationary Navigation Overlay Service (EGNOS)

- Commissioned for aviation use in March 2011 (https://egnos-user-support.essp-sas.eu/)
- Serves Europe and surrounding countries with specific agreements with the European Union.
- It's use in other domains such as surveying, agriculture or maritime is increasing
- Developing a Dual-frequency, multiple constellation service - 2028

Michibiki Satellite Based Augmentation System (MSAS)

- Commissioned in 2007
- Serves Japan and surrounding area
- Provides LNAV service, establishing LPV

GPS Aided Geostationary Earth Orbit (GEO) Augmented Navigation (GAGAN)

- Commissioned in December 2013 (http://gagan.aai.aero/gagan/)
- Serves India and the surrounding area

System of Differential Correction and Monitoring (SDCM)

- Currently under development
- Augmentation of GPS and GLONASS
- Will serve Russia and the surrounding area

Korean Augmentation Satellite System (KASS)

- Commissioned in 2024
- Will serve South Korea

BeiDou Satellite Based Augmentation System (BDSBAS)

- In test undergoing certification
- Will serve China and the surrounding area

Augmented Navigation for Africa (ANGA)

- Demonstration service started in 2020
- Expected L1 services in 2025

Southern Positioning Augmentation Network (SouthPAN)

- Early services in 2022
- Aviation services in 2028
- Will serve Australia and New Zealand (https://www.ga.gov.au.sciencetopics/positioning-australia/about-the-program/southpan)

Interoperability

To ensure seamless operation, each SBAS system has been developed to the same standard as defined by the International Civil Aviation Organization (ICAO) Standards and Recommended Practices (SARPs) Annex 10. SBAS avionics designed in accordance with the RTCA or EUROCAE Minimum Operational Performance Standards (MOPS), are interoperable with SBAS systems compliant with the SARPs and the avionics can transition from one SBAS system to another as the aircraft transitions through different SBAS coverages. SBAS service providers meet on a regular basis in an Interoperability Working Group as a forum to discuss SBAS implementation to maintain interoperability.

SBAS in the Future

- Satellite navigation systems reduce the dependence on aging, ground-based and legacy infrastructure, enabling rationalization of these ground-based technologies.
- The use of performance-based SBAS navigation increases operational efficiencies with resulting cost savings and emission reductions.
- SBAS use in aviation is increasing to support other aviation applications in the CNS/ATM domain. For instance, SBAS provides the required level of accuracy for some national ADS-B regulations/mandates (e.g. US).
- With the future introduction of dual-frequency multiple constellation (DFMC) SBAS service, satellite navigation service availability increases integrity in areas with dynamic ionospheres and during ionosphere storms. DFMC SBAS service does not change the existing L1 SBAS service and DFMC SBAS receivers will also be able to use the existing single-frequency service.