Global SBAS Status

Interoperability Working Group 22
Munich, Germany
January 17, 2012

Agenda

- Background
- Benefits
- Interoperability
- System Status
- System Evolution
- Issues

SBAS Background

- Satellite Based Augmentation System (SBAS) provides the accuracy, integrity, service continuity and availability needed to rely on Global Navigation Satellite System (GNSS) navigation for all phases of flight, from en route through category I approach
- SBAS technology provides the opportunity to cover very large areas of airspace and areas formerly not served by other navigation aids
- SBAS adds increased capability, flexibility, and often, more cost-effective navigation options than legacy ground-based navigation aids
- SBAS can be used in many non-aviation applications

SBAS Background

- International Civil Aviation Organization (ICAO) Standards And Recommended Practices (SARPs) provides overarching standards and guidance for Global SBAS implementation
- SARPs criteria define the SBAS standards for Approach with Vertical guidance (APV) as being a stabilized descent using vertical guidance
- SBAS Interoperability Working Group (IWG) is the forum for SBAS service providers to assure common understanding and implementation of the SARPs
- IWG forum allows coordinated development of interchangeable avionics technology designed to easily transition from one SBAS region to another

SBAS Benefits

- SBAS service is available for free
- SBAS enables Performance Based Navigation (PBN) to improve efficiency, capacity, and reduction of environmental impacts and is the lowest cost enabler for Required Navigation Performance (RNP)
- SBAS is an enabler for Federal Aviation Administration (FAA) Next Generation Transportation System (NEXTGEN) and the European Commission (EC) Single European Sky Air Traffic Management Research (SESAR)

SBAS Benefits

- Dual-frequency SBAS will support increased service availability during ionospheric storms
- SBAS supports the decommissioning of ground-based Navigation Aids (NAVAIDs)
- SBAS benefits extend beyond aviation to all modes of transportation, including maritime, highways, and railroads

SBAS Benefits – En-route

- SBAS is considered a primary navigation system
- SBAS allows for Receiver Autonomous Integrity Monitoring (RAIM) check elimination
- SBAS supports Area Navigation (RNAV) and RNP
  - SBAS enables all RNAV requirements for implementation of 'T' and 'Q' routes
- SBAS allows the flexibility to design more efficient airspace and instrument procedures
- Significant reduction in track dispersion

SBAS Benefits - Terminal

- Supports Trajectory Based Operations (TBO)
  - 4-D Operations (Continuous Descent Approach (CDA))
  - Significant reductions in fuel consumption
- Significant reduction in track dispersion

SBAS Benefits - Approach

- Provides Category I (CAT I) Vertical guidance at any qualifying runway
  - Localizer Performance with Vertical Guidance (LPV)
  - SBAS service does not require the installation or maintenance of ground-based landing system navigation aids
- SBAS provides immunity to improper setting of aircraft barometric altimeters
- SBAS is immune to barometric and temperature fluctuations
- Positive guidance RNP 0.3 across service areas

SBAS Interoperability - SARPs

- ICAO SARPs Annex 10 and Aviation Standards supports interoperability amongst SBAS service providers
  - Supports seamless transition from one SBAS service area to another SBAS service area
  - Provides continued support to legacy single frequency users by ensuring backward compatibility

SBAS Interoperability - IWG

- SBAS IWG objectives established to support technical interoperability and cooperation
  - Objective 1: Harmonize SBAS modernization plans
  - Objective 2: Forum for discussion on SBAS standards
  - Objective 3: Harmonize technical improvements from operations and users feedback
  - Objective 4: Research and Development (R&D) cooperation on key SBAS technologies
  - Objective 5: Support joint SBAS promotion

SBAS Status:
Operational Systems

- Wide Area Augmentation System (WAAS) – United States
  - Operational since 2003
  - Supports en route, terminal and approach operations
    - CAT I-like approach capability (LPV-200)
- Multi-function Transport Satellite (MTSAT) Satellite-based Augmentation System (MSAS) - Japan
  - Operational since 2007
  - Supports en route, terminal and non-precision approach operations
- European Geostationary Navigation Overlay Service (EGNOS) – European Union
  - Open Service was declared in October 2009
  - Safety-Of-Life Service has been operational since March 2011
  - Supports En Route, Terminal and Approach operations
    - APV-1 (LPV equivalent) operational capability

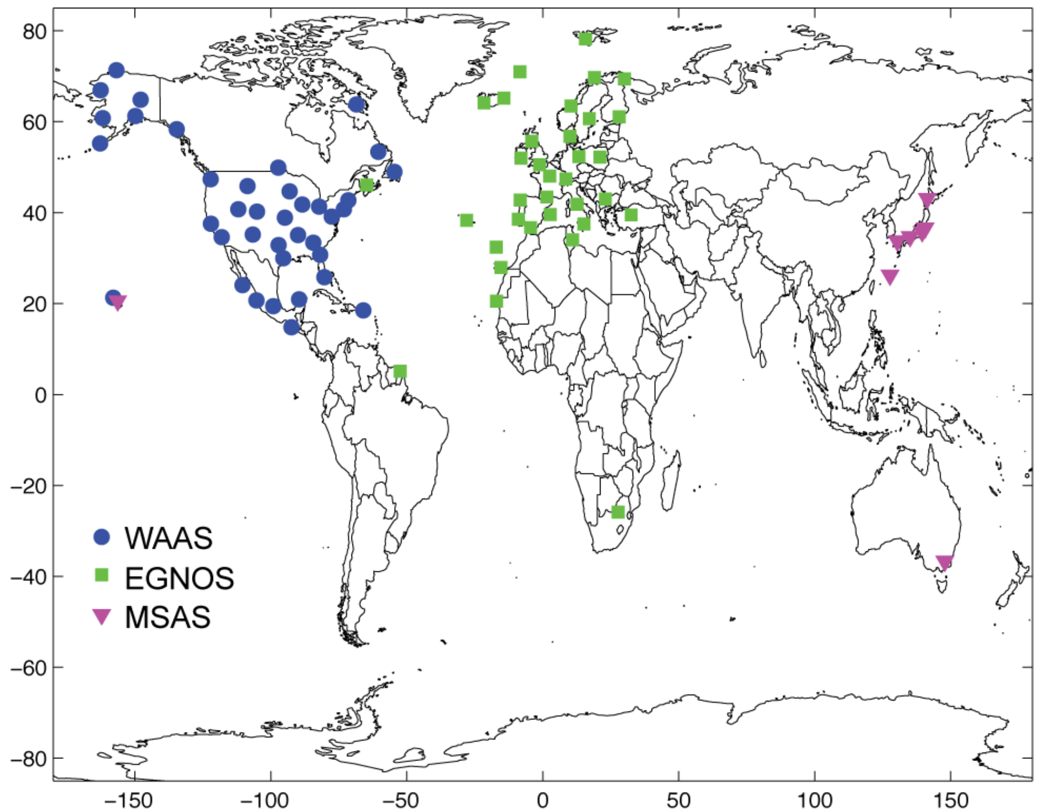
SBAS Status:
Developing Systems

- Global Positioning System (GPS) Aided Geostationary Earth Orbit (GEO) Augmented Navigation (GAGAN) - India
  - In development with plans for horizontal and vertical guidance
  - Final Acceptance Testing planned in 2012
- System of Differential Correction and Monitoring (SDCM) - Russia
  - In development with plans for horizontal and vertical guidance

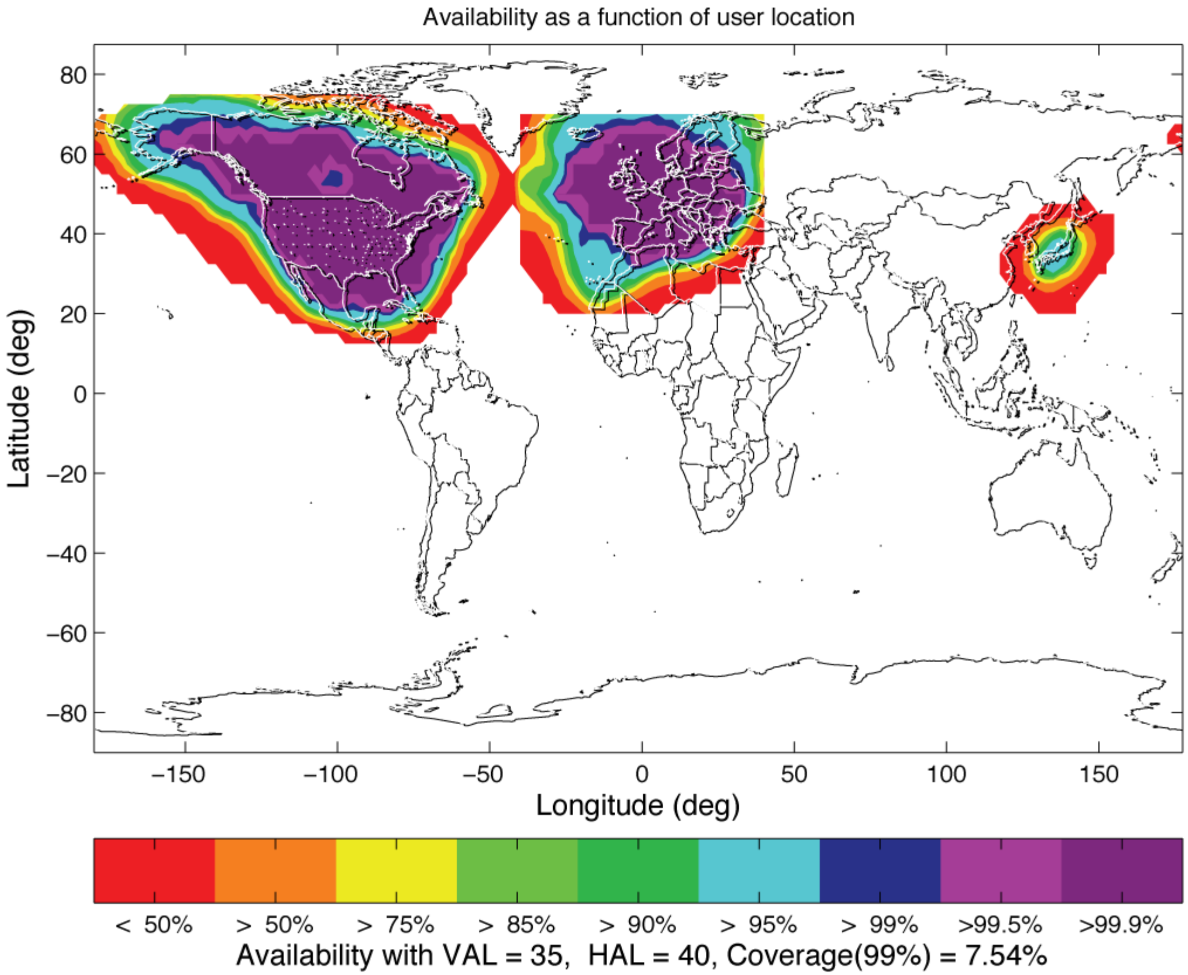
SBAS Evolution

- GNSS Dual Frequency Operations
  - Increases SBAS availability and performance by direct mitigation of ionospheric signal delay
  - Improves robustness against unintentional interference
- SBAS Service Provider Objectives
  - Avionics manufacturers to support multi-constellation/multi-frequency avionics as flight-certified navigation solutions
  - Evaluate inclusion of additional GNSS constellations in SBAS such as Galileo and Global Navigation Satellite System (GLONASS)
  - Provide continued support to legacy L1-only users
  - Support cooperative development of future SBAS standards

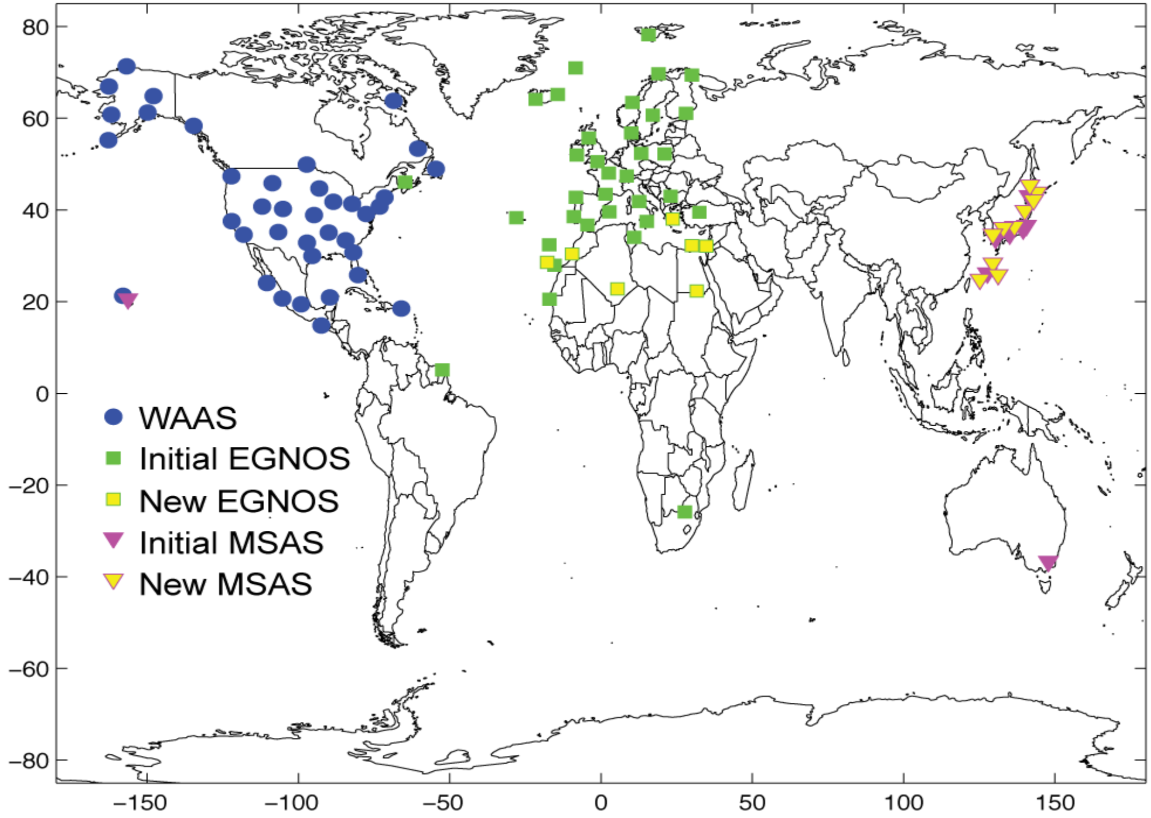
Current Reference Networks



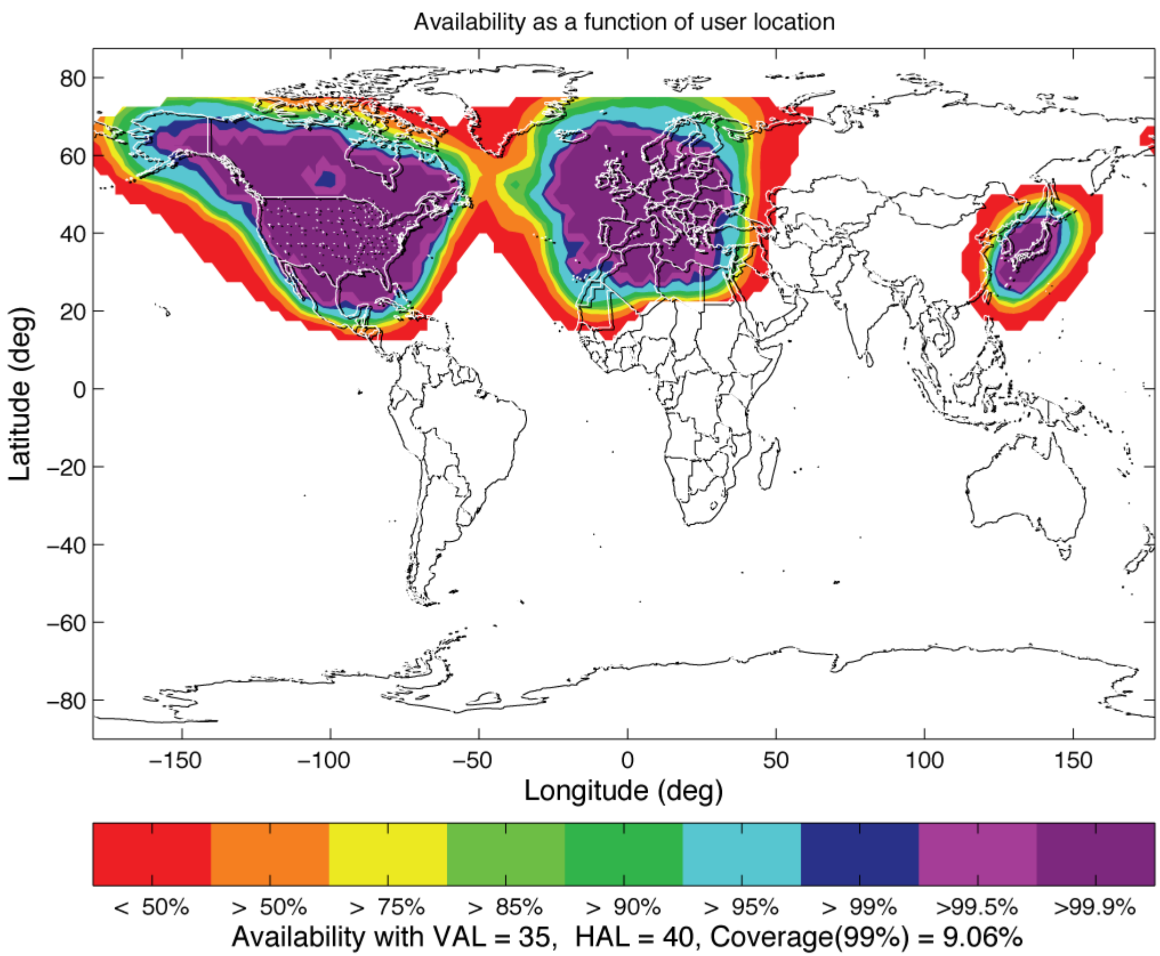
Current Coverage



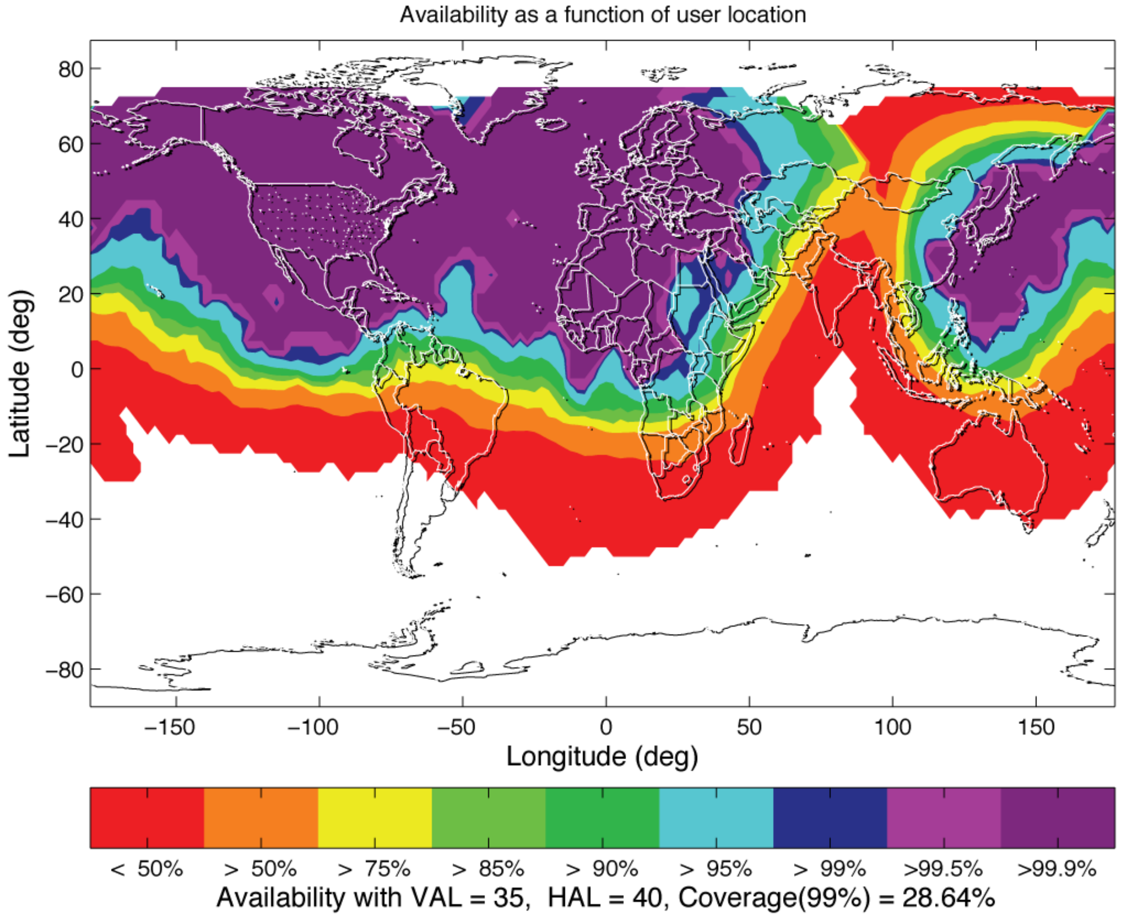
Current Plans for Expanded Reference Networks



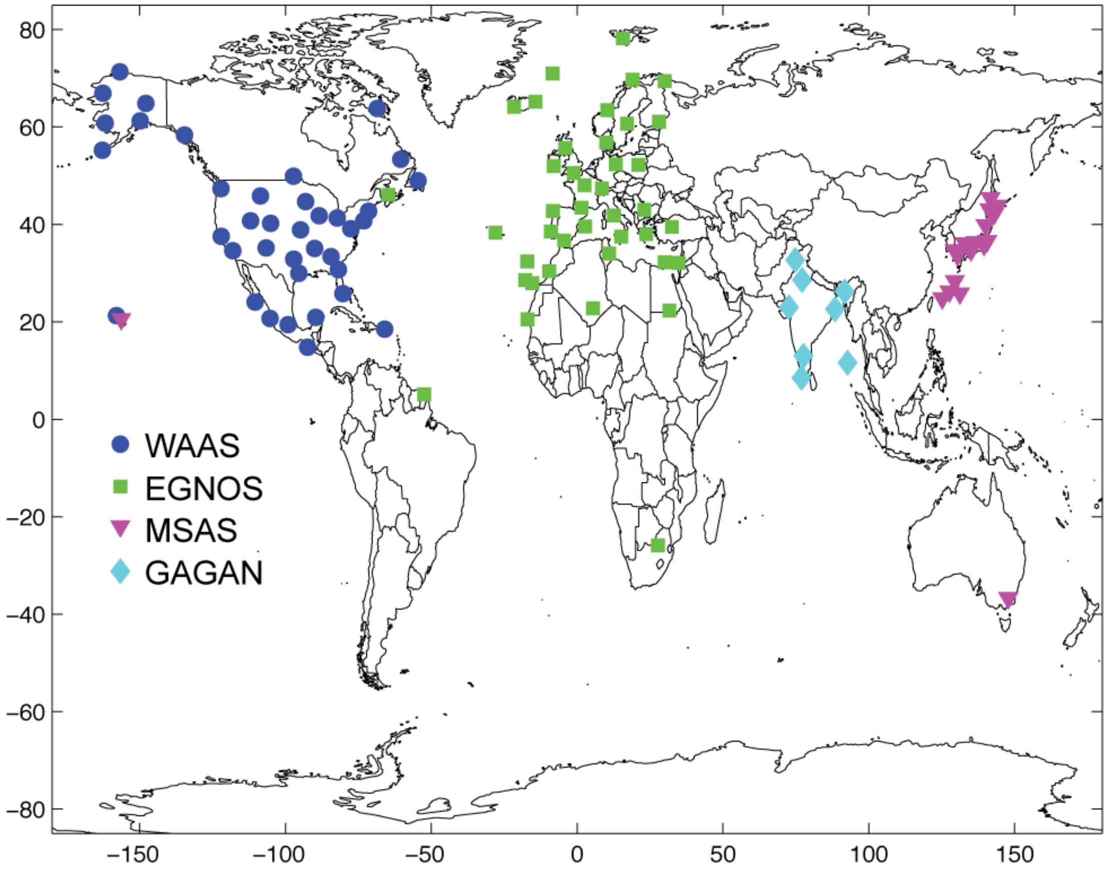
Improved Single Frequency Coverage



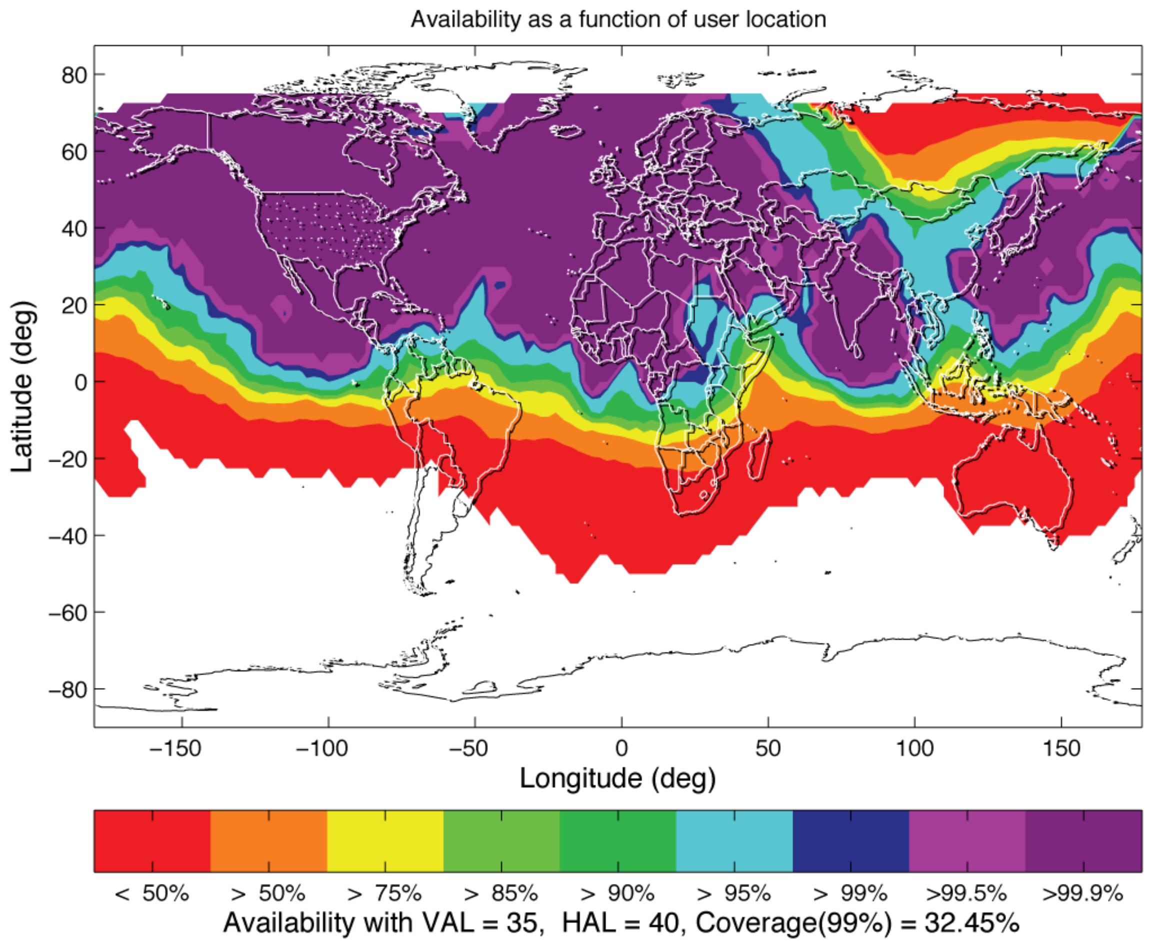
Dual Frequency Coverage (WAAS, EGNOS, MSAS)



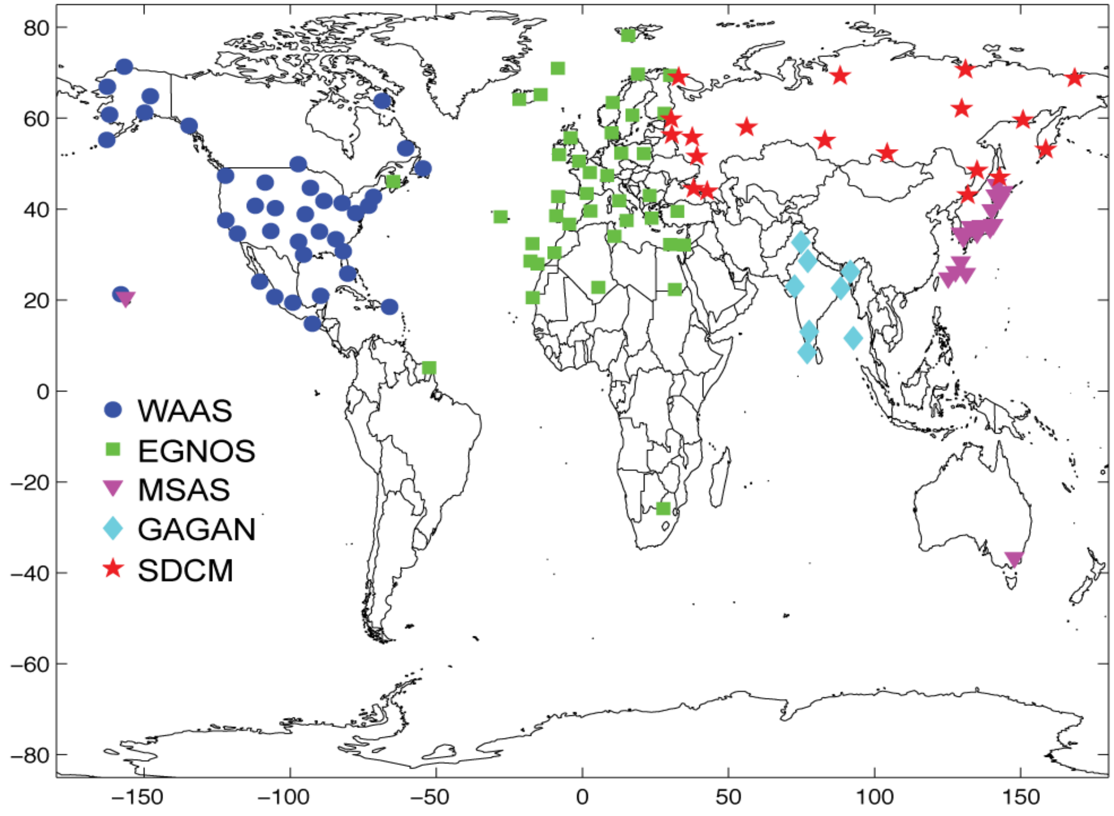
Reference Networks with GAGAN



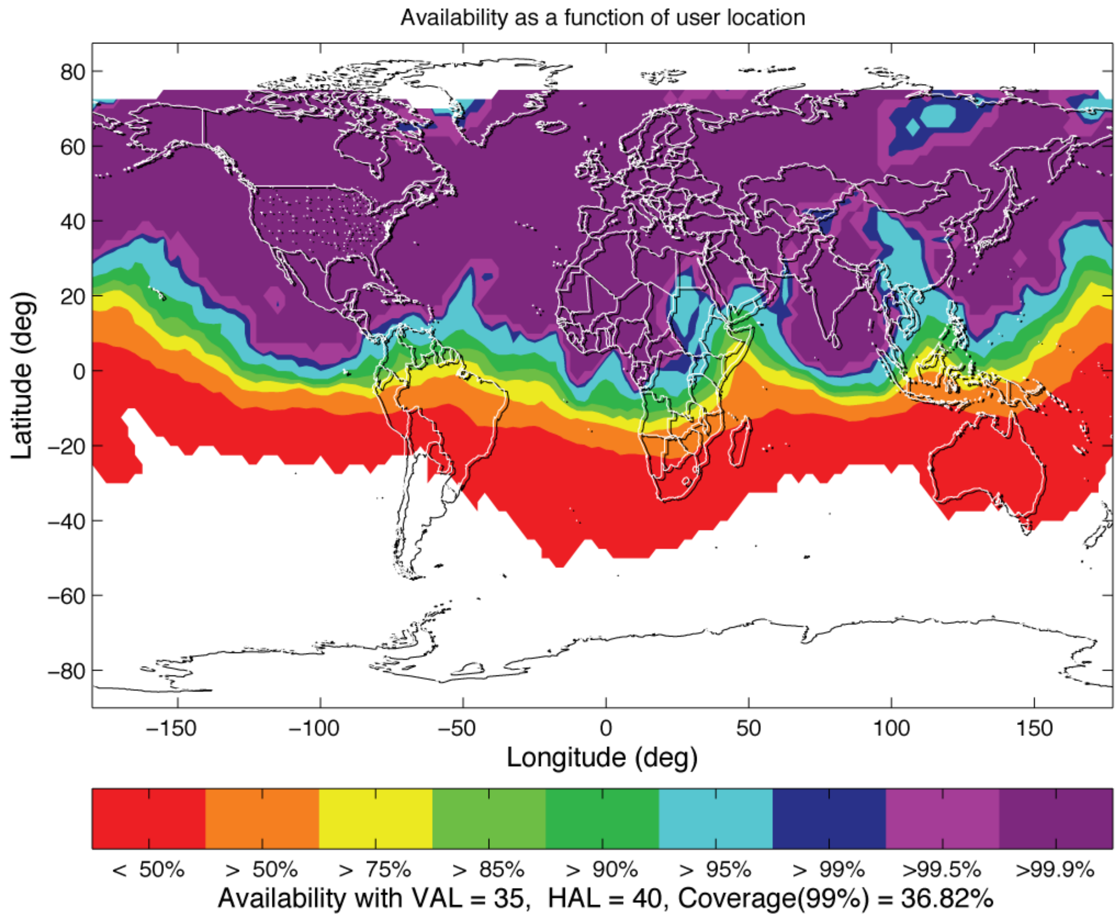
Dual Frequency Coverage (with GAGAN)



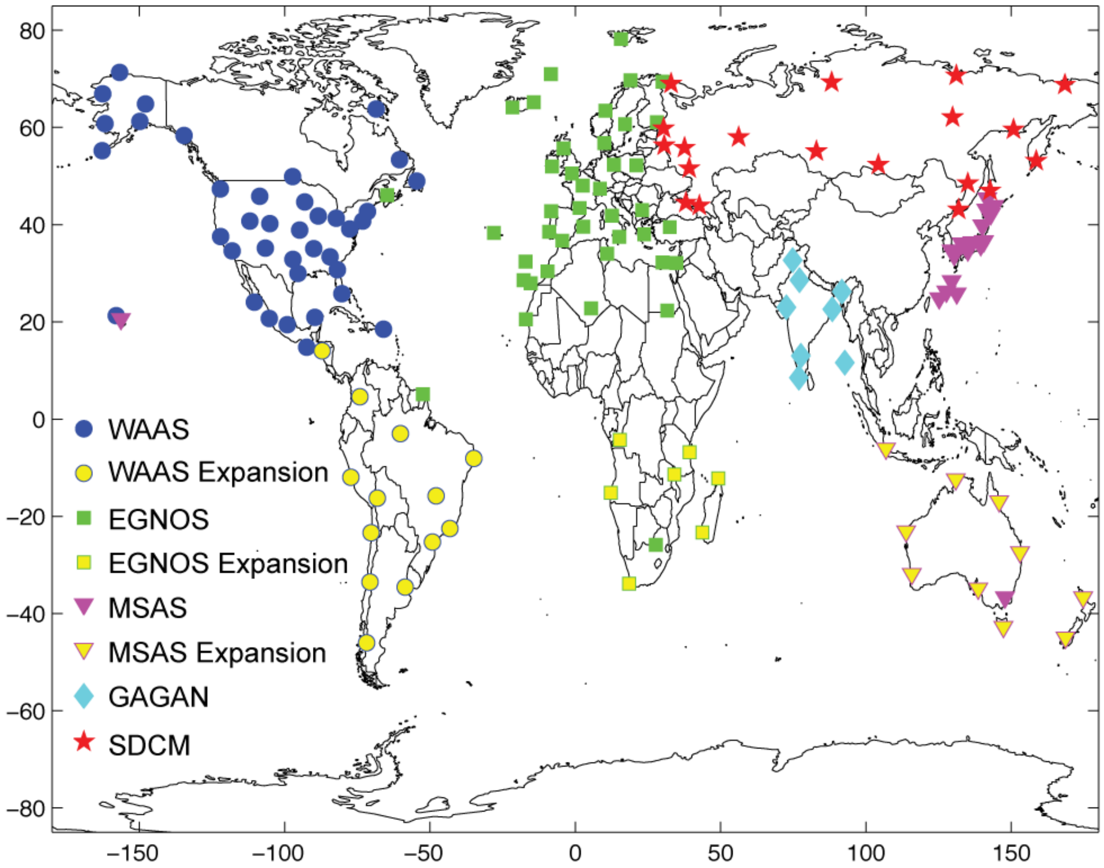
Reference Networks with GAGAN and SDCM



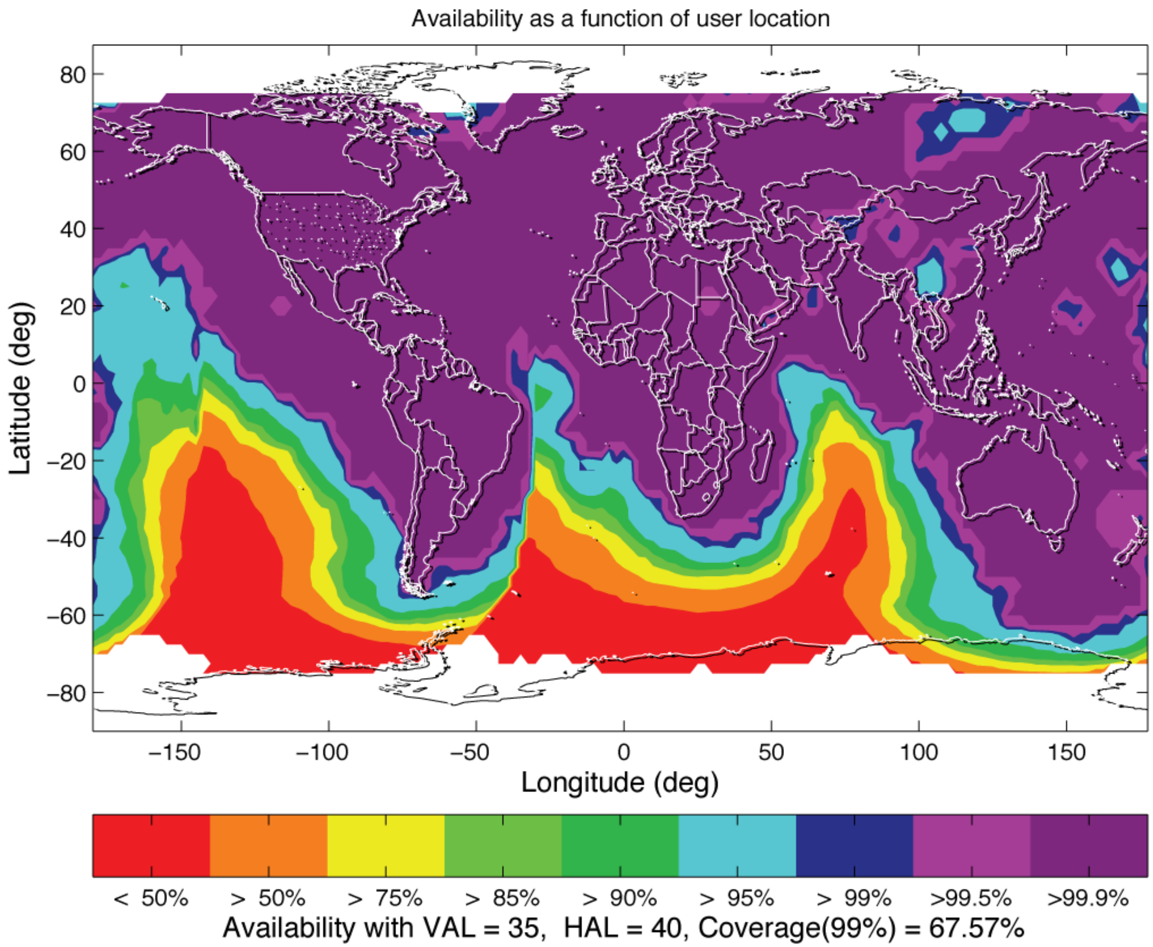
Dual Frequency Coverage (with GAGAN + SDCM)



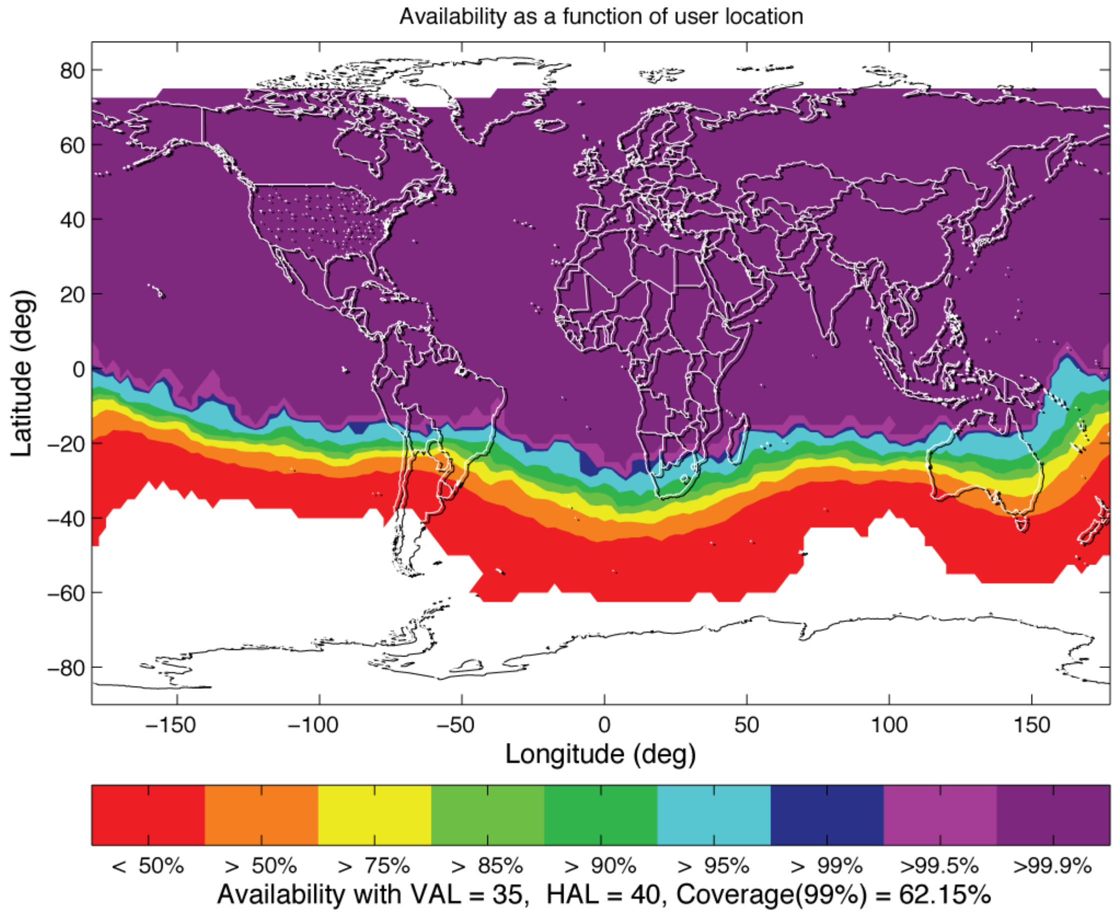
Expanded Networks



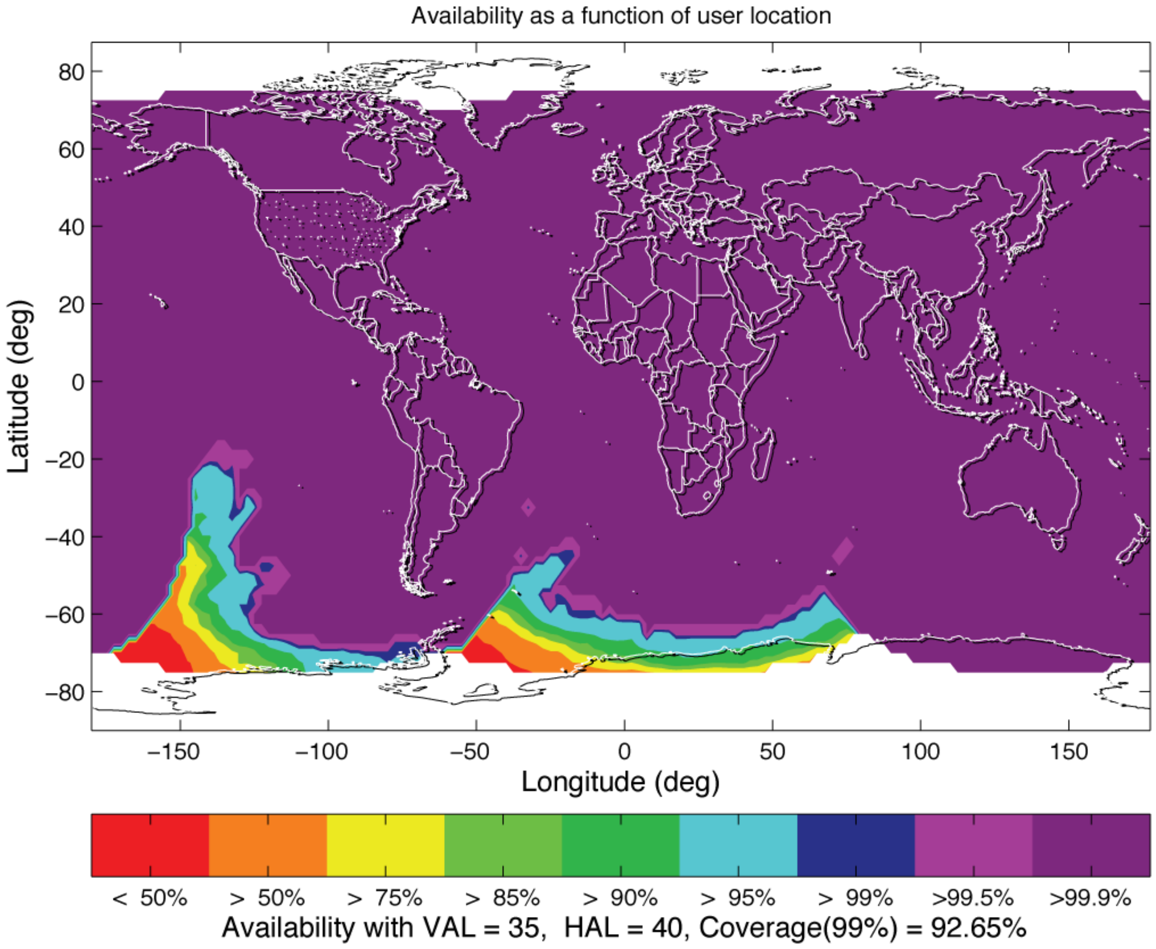
Dual Frequency, Expanded Networks



Dual Frequency + Second Constellation (Galileo)



Dual Frequency, Dual GNSS, Expanded Networks



Issues Being Addressed

- Seamless transition between SBAS service areas
  - Evaluating transitions between SBAS and RAIM, along with transitions between two SBASs, and between SBAS and GBAS
- Common interpretation of standards amongst SBAS developers
  - Established a work plan for development of a definition document to support a dual-frequency, multi-constellation user
- Currently Limited Global Coverage
  - Global coverage to be expanded with addition of GAGAN and SDCM
  - Availability of worldwide LPV-200 service expected with addition of a second frequency, extended networks and additional GNSS constellations

Conclusions

- Single Frequency SBAS offers significant benefits within covered service areas
- Dual Frequency extends coverage outside reference networks & allows LPV operation in equatorial areas and during ionospheric storms
- Expanding SBAS networks into southern hemisphere would allow global coverage of land masses
- Additional GNSS constellations allow even greater coverage with fewer stations
- Multiple constellations enable development of interchangeable avionics technology