Aviation Benefits of GNSS Augmentation

Workshop on the Applications of GNSS

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Overview

- LAAS Capabilities and the Future
- Benefits of WAAS
- Global SBAS and Aviation – Where are We Headed?
U.S. GPS Augmentation Programs Designed for Aviation

WAAS

Enroute Oceanic
Enroute Domestic
Terminal
Approach
Surface

LAAS

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Local Area Augmentation System (LAAS)

- Ground Based Augmentation System (GBAS)
- Designed for aviation use

**Aviation Capabilities**

- Precision approach for ILS Category - I, II, III approaches
- Multiple runway coverage at an airport
- 3D RNP procedures (can be supported by multiple navigation sources)
- Continuous Decent Arrivals (CDA)
- Navigation for closely spaced parallel runways
LAAS Next Steps

- Category-I system design approval at Memphis – Complete
- Category-III ICAO technical validation by - 2010
- Category-III final investment decision by - 2012
Wide Area Augmentation System (WAAS)

- Satellite Based Augmentation System (SBAS)
- Designed for aviation use, but available and used by many GPS users today
- Localizer Performance Vertical (LPV)-200 approach is comparable to ILS Category I
GPS WAAS/ SBAS Aviation Benefits

- Increased Runway Access
- More direct en route flight paths
- New precision approach services
- Reduced and simplified equipment on board aircraft
- Potential elimination of some ground-based navigation aids (NDB, VOR, ILS) can provide a cost saving to air navigation service provider
**SBAS Future Considerations**

- Dual frequency GNSS services in protected aeronautical bands
  - Enables aircraft receiver direct estimation and removal of ionospheric delay errors
    - Single largest source of vertical position uncertainty
- Most significant remaining threats are satellite failure based
  - Design a new VPL equation targeting single satellite faults
- India, Russia (and potentially China) are developing SBAS systems
- Investigate potential to expand LPV to global coverage
Current SBAS Reference Networks
Current LPV-200 Coverage
(Single Frequency GPS)

Availability as a function of user location

Modeling provided by Stanford University

WAAS
EGNOS
MSAS

Availability with VAL = 35. HAL = 40. Coverage(99%) = 7.54%

Note: Model does not account for Intelsat Galaxy 15 satellite anomaly
Future LPV-200 Coverage
(Dual Frequency GPS)

Modeling provided by Stanford University

Availability as a function of user location

Availability with VAL = 35. HAL = 40. Coverage(99%) = 28.64%
Current + Future Planned Reference Networks
Future LPV-200 Coverage
(Dual Frequency GPS + Additional SBAS)

Availability as a function of user location

Modeling provided by Stanford University

WAAS
EGNOS
MSAS
GAGAN
SDCM

Availability with VAL = 35.  HAL = 40.  Coverage(99%) = 36.82%
Current + Future Planned + Expanded Reference Networks

*Map showing current and future planned reference networks across the globe.*

Legend:
- **WAAS**
- **WAAS Expansion**
- **EGNOS**
- **EGNOS Expansion**
- **MSAS**
- **MSAS Expansion**
- **GAGAN**
- **SDCM**

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Future LPV-200 Coverage
(Dual Frequency GPS + Additional SBAS and Expanded Networks)

 Modeling provided by Stanford University

Availability as a function of user location

WAAS
EGNOS
MSAS
GAGAN
SDCM

Availability with VAL = 35.  HAL = 40. Coverage(99%) = 67.57%
Future LPV-200 Coverage
(Dual Frequency GPS + Expanded Networks + Two GNSS Constellations)

Availability as a function of user location

Modeling provided by Stanford University

WAAS
EGNOS
MSAS
GAGAN
SDCM

Availability with VAL = 35. HAL = 40. Coverage(99%) = 92.65%
Summary

• Single frequency coverage is good within the countries fielding SBAS
• Dual frequency extends LPV coverage outside reference networks
• Expanding networks into southern hemisphere could allow global coverage of land masses
• Multi-Constellation SBAS allows even greater coverage with fewer stations
  – Compatible Geodesy and Time Standards are Important
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