Short and Long-Term Planning Considerations

*The Atmosphere and its Effect on GNSS Systems*

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*Dr. S. Vincent Massimini*
Migration to a GNSS Service

• Major GNSS services extend beyond national boundaries
  – Core constellations offer worldwide service
  – SBAS covers continental areas

• A regional approach to migrating from ground NAVAIDs to GNSS appears most effective
  – Implementation and research, development and planning

• GNSS is still an evolving technology
  – Dual frequency applications will dramatically improve service in South America
    • Only a few years away
Implementing a GNSS augmentation is a relatively long process
  – Minimum of 5 years, and could be longer

Planning should give due consideration to GNSS modernization and other technological advancements
  – According to current schedule GALILEO and dual-frequency GPS should be available in the 2013 to 2015 timeframe
  – Unfortunately, the schedule for GNSS modernization has shown to be somewhat elastic

FAA has started exploring potential GNSS architectures in the GPS-III, Block C timeframe (2030 and beyond)
  – Study aims at a level of service equivalent to LPV-200 worldwide

Multi-frequency, multi-constellation solutions are also being investigated in Europe
General Considerations

Based on current state of the art, the programmatic risk of a potential single-frequency SBAS implementation to provide APV in all but the southern-most part of South America appears to be very high:
- SBAS monitoring of GPS satellites could contribute a much improved availability of ER/NPA service

- Dual frequency SBAS (with GPS and/or GALILEO) would require fewer monitoring assets and should provide APV everywhere

- GBAS should provide adequate Category I precision approach service
  - Serve as a stepping stone toward future GBAS Cat II/III service
  - Risks (impact on service) associated with localized ionospheric effects need to be carefully evaluated
Considerations Related to Ionospheric Effects

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- Ionospheric effects in South America have not yet been characterized as extensively as in mid-latitudes

- A large depository of data and analyses are needed to support GNSS-based approach and landing services

- If an SBAS implementation is considered, a good characterization will be needed for
  - Variations in ionospheric delays over wide areas
    • Requires a network of reference receivers distributed over the entire service area (300 to 600 km apart)
  - Errors induced by the thin shell model
    • Particularly in equatorial anomaly region
  - Ability to detect depletions (misdetection and false alert risks)
    • And impact on service associated with detections
Considerations Related to Ionospheric Effects

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• Wherever a GBAS implementation is considered, a good characterization will be needed for
  – Variations in ionospheric delays over the local area
    • Requires a few closely space receivers (5 to 10 km) in area of interest to evaluate gradients in East-West and North-South directions over 10 to 15 km (final approach distances)
  – Characterization will depend on magnetic latitude

• For all types of GNSS implementation
  – Probability of loss of service due to scintillation induced losses of lock
    • Probability will depend on the navigation service
    • On the number of satellites in view, and
    • On the level of ionospheric scintillation