GNSS Evolutionary Architecture Study (GEAS)

CGSIC
20 September 2010

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GEAS Objectives

• Evaluate GNSS-based architectures to provide robust LPV-200 service worldwide circa 2020
  – Multiple dual frequency GNSS constellations in protected aeronautical bands
  – Direct estimation and removal ionospheric delay errors
  – Opportunity to consider advanced RAIM (ARAIM) techniques
• Enable a smooth integration of future GNSS in the user equipment
• Near term implications for WAAS (SBAS)
  – India and Russia are developing SBAS systems
  – Investigate potential to expand SBAS to provide global LPV coverage
  – Multiple-constellation SBAS
Current International Signal Plans

- GPS (US)
- GLONASS (Russia)
- Galileo (Europe)
- COMPASS (China)
- IRNSS (India)
- QZSS (Japan)
- SBAS (US Europe India Japan)

Future CDMA signal

Frequency (MHz):
1170 1180 1190 1200 1210 1220 1230 1240 1250 1260 1270 1280 1290 1300
1560 1570 1580 1590 1600 1610
Current Reference Networks

-Courtesy of Todd Walter, Stanford University-
Current LPV-200 Coverage
(Single Frequency GPS)

Availability as a function of user location

WAAS
EGNOS
MSAS

Courtesy of Todd Walter, Stanford University

Availabilty with VAL = 35. HAL = 40. Coverage(99%) = 7.54%
Future LPV-200 Coverage
(Dual Frequency GPS)

Availability as a function of user location

WAAS
EGNOS
MSAS

Courtesy of Todd Walter, Stanford University

Availability with VAL = 35. HAL = 40. Coverage(99%) = 28.64%
WAAS, MSAS, EGNOS, GAGAN and SDCM Reference Networks

-Courtesy of Todd Walter, Stanford University
WAAS, MSAS, EGNOS, GAGAN & SDCM
(Dual Frequency GPS)

Availability as a function of user location

Availibility with VAL = 35. HAL = 40. Coverage(99%) = 36.82%

Courtesy of Todd Walter, Stanford University
Expanded Networks

Courtesy of Todd Walter, Stanford University
WAAS, MSAS, EGNOS, GAGAN & SDCM
(Dual Frequency GPS + Expanded Networks)

Availability as a function of user location

Availability with VAL = 35. HAL = 40. Coverage(99%) = 67.57%

Courtesy of Todd Walter, Stanford University
WAAS, MSAS, EGNOS, GAGAN & SDCM
(Dual Frequency GPS + Expanded Networks + Two GNSS Constellations)

Availability as a function of user location

Courtesy of Todd Walter, Stanford University

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

- 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