NATS

Operational Validation of EGNOS for Safety of Life Applications

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Presentation Overview

- Validation Motivations
- Validation Method
- Performance Monitoring
 - Existing
 - Limitations
- Validation Schedule
- Monitoring EGNOS in NATS
 - Site Details
 - Processing Signal Content
- Results from Tools
- Conclusions

Validation Motivations

- Prove that EGNOS is usable for Safety of Life (SoL) Applications
- Provide information to the EGNOS technical file, which will consist of the following:
 - Design Safety Case
 - Independent Assessment Report
 - Operations Safety Case
- Objective of Independent Assessment Report is to demonstrate system fulfils safety requirement
 - Availability
 - Continuity
 - Integrity

Validation Method

- GSA Provide
 - Evaluation methodology recommendations
 - Data presentation recommendations
 - Harmonization report format.
- Assess using data sourced from the following location
 - RIMS sites (ASQF input)
 - 6 independent locations (PACF input)
 - Eurocontrol's EGNOS Data Collection Network (EDCN members)

Performance Monitoring Networks

EGNOS Performance Monitoring Actors

- Image
 - Run by ESA as an independent network
 - Uses Network of Septentrio Polar Rx2 receivers
 - Members (AENA, ESA, ESSP, Inguassu, INMARSAT, NMA, PAS, ISMB, Skyguide, Universitat De Valencia)
- EGNOS Data Collection Network (EDCN)
 - Run by Eurocontrol
 - Setup to develop and test processing tools
 - Devise ways of monitoring the system requirements
 - Uses various receivers
 - Providing data for the EGNOS Technical File
 - Members (Budapest, Delft & Sofia University, NATS, Eurocontrol, ESSP, Skyguide, DSNA, gAGE/UPC, Nav Portugal, ENAV, IntegNav, ENAC, AENA, Pildo)

Validation Schedule

- Validation will be carried out on V2.2 of EGNOS
 - In final deployment
 - Due to be fully deployed
 - Data for Independent assessment report collected on V2.2
- Data collection for validation will take place over a 6 month period
- System is expected to be certified December 2009.

Performance Monitoring Limitations

Limitations

- EGNOS provides location dependant corrections
- Error sources can be introduced by the local environment
- Receiver Issue
 - Common receiver problems
 - Most receivers used not certified
- Hardware/tool problems

NATS Performance Monitoring Facilities

Southampton Setup

- Certified Garmin Receiver
- Ashtech Receiver

Sumburgh Setup (Shetland Isles Lat 59.8 degress, Long -1.2)

- 3 Novotel OEM receivers
- Logging and Comms PC's
- Why Sumburgh
 - Poor user location
 - Edge of service area
 - RIMS distribution







Assessing and Reducing Poor Effects of Logged Signals

Local Processes

- Removing aspects of the signal
- Monitoring specific parameters of the signal

Reducing Effects of Validation Environment

- Reduce the effect of the multipath environment of the site
- Use multiple receivers
- Assess GPS code minus carrier-phase signal

Quantifying the Ionospheric Correction

- Value as seen at the performance monitoring site
- The Ionospheric correction can be assed using data gained from the following sources:
 - EGNOS Ionospheric Correction
 - Ionospheric error calculated using L1 and L2 locally

Estimating Components in the Signal

- The residual from the code minis carrier signal is as follows:
 - $pcode pphase = 2I + MEAScode + MEASphase + ucode uphase + Mcode Mphase \Delta$
- Component parts of the signal

• There is a close relationship between the performance of two receivers closely spaced antenna.





Method for Discriminating Multipath from Noise



Reducing the Multipath Effects



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Visualising Effects of Multipath tool

- Reduced mean variation
- Most effect at low elevations



Checking the Error in the Ionosphere

Ionospheric Validation Tool

Asessing the Error in the EGNOS Iono Correction

- Determine a truth signal
- Use delay derived from L1 and L2 GPS
- Determine the error in the EGNOS Ionospheric correction
- Ensures in Bounding
- •Does not acount for temperature variation

Results from Tool

- For times checked Ionospheric correction was well within bound
- Not setup as an automated tool
 - Technical difficults to implement as automated check



Conclusions

Validating EGNOS

- Data collection period for Validation is fast approaching
- Performance Monitoring is important in gauging the capability of the system to provide safe information.

Assessment of Local Environment

- This reduction in the effects of Multipath will allow the SIS to be scrutinised fairly.
- Does not propose a solution to completely eradicate the effects of Multipath,

Assessment of the Ionospheric Correction

- Ionospheric Correction from the data broadcast by EGNOS was well within the sigma values
- Not an automated tool yet

Thank you

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Presentation Summary

- Performance evidence will be used in the EGNOS technical File, therefore the evidence needs to provide a fair representation of the signal.
- Monitoring EGNOS at the edge of service coverage will provide confidence in the systems overall performance.
- Improving Limitations of performance monitoring site
 - Details of a method used to reduce Multipath based on assessing the difference between the Code Minus Carrier of two receivers is presented.
 - Additionally a method developed to assess the Ionosphere is showed.

Notes

- No integrity event has been seen since start of 2007
- Continuity around 10^-4 in core ECAC
- SIS broadcast since start of 2008
- 6 RIMS to be deployed in 2.3-2.4
- ESA think system is ready for certification
- GPS constellation may change over 6 months