Welcome to the second issue of the ESTB News. Much has happened since May, and this issue recognises both the successes and challenges of the EGNOS development during the last three months.

Two successful trials are reported in this newsletter: an aviation trial at high-latitudes that rewrites the rules about EGNOS availability; and SISNET, a novel approach for delivering the EGNOS messages over the Internet. Perhaps the greatest challenge is that of coaxing the Artemis satellite into operation following problems during the launch process. Artemis is due to play an important role within EGNOS, and we applaud the professionalism of the combined ESA/industry team that is recovering the Artemis mission. Elsewhere in this ESTB Newsletter you will find an invitation to the second ESTB Workshop, an article explaining integrity, and ESTB system news.

We hope you enjoy ESTB News. Please send us your comments, suggestions and inputs for further issues.

Artemis Satellite Recovery Continuing Successfully

Artemis is ESA’s latest communications satellite. Besides advanced payloads for data relay and mobile communication, it carries a navigation payload for disseminating from 2003 onwards the EGNOS ranging, wide area differential correction and integrity signal for use by safety-critical transport and other navigation services.

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Integrity Explained

EGNOS will provide a European-wide, standardised and quality-assured augmentation service suitable for a diverse range of applications. Integrity is a key quality and safety parameter, alerting users when the system exceeds tolerance limits.

EGNOS will broadcast wide-area differential corrections to improve accuracy, and alert users within six seconds if something goes wrong (integrity).

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ESA Announces 2nd ESTB Workshop

ESA’s second one-day ESTB workshop will precede the “NavSat 2001” conference and will take place on 12th November at Nice in France. It should be particularly attractive to companies or users interested in exploiting GNSS for novel services and applications.

Workshop topics will include an overview of the ESTB performance and its near-term evolution, details of EGNOS compatible user equipment, and the results of recent trials.

Participation is free of charge. Registration can be done over the Internet or via email. The deadline for registration is 12th October 2001.

Flight Trials Confirm EGNOS Signal Availability At High Latitudes

Aviation users have very stringent requirements for availability, and it is important to confirm that signal availability is maintained at high latitudes with low GEO elevations.

Aviation users have very stringent requirements for service availability - typically between 99% and 99.999% depending on the operational need. EGNOS service availability is dependent on maintaining connectivity between the user receiver and at least one of the EGNOS geostationary satellites (GEOs). Even using three well-spaced GEOs to help maximise signal availability, it is important to confirm that signal occultation at high latitudes does not result from terrain masking or airframe masking during the manoeuvres.

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Integrity requirements are application-specific and generally specified in terms of three parameters with values specified by governing institutions.

Integrity is generally specified in terms of an alert limit, a time-to-alarm, and a probability of non-integrity detection. These are all present, explicitly or implicitly, in the previous integrity definitions.

The alarm limit or alert limit (AL) for a measured parameter is the error tolerance not to be exceeded without issuing an alert to the user. It represents the largest error that results in a safe operation.

The time-to-alarm or time-to-alert is the maximum permitted duration between the onset of a failure and an alert being issued by the user’s receiver.

The probability of non-integrity detection quantifies risk. It represents the probability that an error exceeds the AL without the user being informed within the time to alert.

The values assigned to these three parameters depend on the specific application and intended operation, and are generally determined by institutions (e.g., the International Civil Aviation Organisation or the International Maritime Organisation).

EGNOS receivers estimate protection levels based on data broadcast by the GEO satellites, the user/satellite geometry, and the probability of integrity non-detection.

EGNOS broadcasts corrections for errors in the GPS satellite clock and ephemeris data, as well as corrections for the ionospheric delay experienced by a single frequency user. It also broadcasts parameters that describe the residual range errors after application of both the clock and ephemeris corrections (the User Differential Range Error - UDRE) and the ionospheric corrections (Grid Ionospheric Vertical Error - GIVE).

The receiver combines satellite/user geometry information with EGNOS-corrected pseudo-ranges and internal estimates of the tropospheric delay to compute the user position. Ideally, the user wants the difference between the computed position and the true position, the true position error (PE), to be less than the AL. However, the true position is not known, and so the PE cannot be determined and an alternative approach is required.

In fact, the receiver continuously estimates a predicted position error, known as the protection level (PL), for each position solution. The PL is estimated based on the UDRE and GIVE parameters and other local error-bound estimates. It is scaled for compatibility with the probability of non-integrity detection so that the PL should always be larger than PE.

Integrity assessments are based on PL and AL. Users will benefit from enhanced quality provided by the EGNOS integrity signal.

A new PL is estimated for each computed position solution. It is compared with the required AL, and an integrity alert triggered if PL > AL.

The relationship between PL, PE,
Flight Trials Confirm EGNOS Signal Availability At High Latitudes ...

A signal availability of 99.68% was achieved during these trials. These results indicate that high latitude masking should have little impact on flight operations once EGNOS procedures have been designed and the GEOs are operational.

The ESTB signal was only available from the AOR(E) satellite during the trials, and was monitored at Gatwick throughout the trial to establish an availability baseline.

The results of these trials, albeit based on a limited data set, give some cause for optimism.

EGNOS messages were unavailable for only 55 seconds from a total flying time of 4 hours and 47 minutes above 60°N. This equates to a signal availability of 99.68%.

Outages were not caused by terrain shielding and did not occur during the approach/departure operations. Outages only occurred during dynamic manoeuvres, and a roll angle of greater than 30° was needed to break lock in the worst case scenario, and might have been avoided if all three GEOs had been available.

From an operational perspective, it should be possible to predict masking when designing an SBAS procedure. If a bank angle of the order of 30° is required within an approach procedure, this turn should be kept outside of the critical SBAS Precision Approach Region - the area in which an SBAS system can be used to provide guidance for a precision approach.

ESTB System News

The ESTB now has ten reference stations since AENA deployed new reference stations at the Canary Islands and Palma de Mallorca in June. AENA has also moved the Cadiz reference station to Malaga. This will significantly improve coverage and integrity over southern Europe.

In July, the ESTB signal-in-space was upgraded to the RTCA DO229A standard. A further upgrade (to RTCA DO229B) is expected in early 2002.

ESTB broadcast schedules and performance statistics are now available on the EGNOS web site at www.esa.int/EGNOS/pages/indexEST.htm. These should prove to be essential reading for EGNOS users.

Ongoing improvements in the robustness of the the ESTB software and the duplication of the Control Processing Facility will enable the ESTB to broadcast full-time early in 2002.

Gran Canaria ACC tower
SISNET: Making EGNOS Available Over the Internet

EGNOS will broadcast correction and integrity messages through three GEO satellites. This is an efficient strategy for many users (e.g. aviation and maritime), but others (e.g. land mobile) may prefer EGNOS corrections to be broadcast over other transmission lines. This has prompted ESA to launch specific activities through its Advance Telecommunications and Navigation Technology Programme (ASTE) to assess and demonstrate architectures where the EGNOS signal could be broadcast using different links.

SISNET (Signal In Space through the interNET) is an internal ESA project that aims to provide access to the ESTB messages over the Internet. ESA has developed the first prototype where a proxy server makes the EGNOS messages available over a local area network to user equipment software implemented on a PC. The user software enables real-time positioning, dynamic ESTB analysis, and the production of EGNOS performance monitoring maps.

SISNET has clear benefits for many users (e.g. land mobile or GIS). It is, however, currently restricted to the ESA development team during this phase of the project. We look forward to bringing news of further developments.

Frequently Asked Questions

Q1: Can the ESTB be used outside Europe?

A1: The ESTB has been designed primarily for operations in the European area. However, its service area can be expanded by installing additional reference stations outside Europe, increasing the ionospheric grid mask to cover the enlarged area, and using Message Type 27 to extend integrity beyond the nominal service area. Some tests have already been performed, and the “expanded ESTB” will be used during 2001/2 in Africa, the Middle East and Eastern Europe.

Q2: When will the ESTB provide a consistent level of service?

A2: A pre-operational service has been available from the ESTB since February 2000, providing a signal during the working day. There are several ESTB upgrades currently in progress designed to improve its robustness and to provide a fully stable signal, 24 hours each day. This will be operational early in 2002.

Please send your questions via e-mail to ESTB@esa.int

Forthcoming Events

www.ion.org

www.estec.esa.nl/conferences/01C14/index.html

www.rin.org.uk


www.navsat-show.com

www.gnss2002.com

Help Us to Help You

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The Editorial Team would welcome your comments, suggestions, and inputs for the December 2001 issue.

Please send emails to ESTB-News@esa.int.

Links and Contacts for Further Information

ESA Navigation Web Page:
http://www.esa.int/navigation

ESA EGNOS Web Page:
http://www.esa.int/navigation/EGNOS/

ESA ESTB Web Page:
http://www.esa.int/EGNOS/pages/indexEST.htm

ESA ESTB Help Desk e-mail:
ESTB@esa.int

ESTB News e-mail:
ESTB-News@esa.int

ESA Galileo Web Page:
http://www.esa.int/navigation/Galileo

EC Galileo Web Page:
http://www.galileo-pgm.org

FAA GPS Product Team:
http://gps.faa.gov/

USCG Navigation Center GPS Page:
http://www.navcen.uscg.mil/gps/