



EGNOS SERVICE NOTICE

Number: 001

Revision: 1.1

To: EGNOS aviation users

Date: 22/07/2011

Subject: MT9-MT17 incoherency status

This Service Notice describes the EGNOS situation on July 2011 regarding the broadcast of GEO orbit information in messages MT9 and MT17, including the impact on certified EGNOS receivers. This service notice replaces the previous versions.

1 DESCRIPTION OF THE MT9 MT17 STATUS

SBAS systems can be designed to provide an optional ranging function that enables the SBAS geostationary satellite to be used like an additional GPS satellite in the constellation.

For this purpose, the SBAS SARPS includes two message types that are used to broadcast necessary information to users concerning the location of the geostationary satellites.

- Message Type 17, called the GEO satellite almanacs message, is used to broadcast the rough location of the geostationary satellite and is intended to be used to help receivers in the selection of SBAS satellites, as well as to speed up the acquisition of data from such satellites. The position's accuracy must be less than 150 km of the true satellite position. The maximum broadcast interval is set to 300s.
- Message Type 9, called the GEO Ranging function parameters (ephemeris) message, is used to broadcast precise orbit information for the geostationary satellite and is intended to be used in the position computation when the ranging signal is used by the user receiver.

The SBAS MOPS (RTCA DO229 C and D) includes a requirement for receivers that use this optional SBAS ranging function to verify the consistency between the information contained in MT17 and MT9 during the signal acquisition phase (either initial or re-acquisition). If the geostationary position information contained in MT 9 and MT17 differs from more than 200 km, the geostationary satellite cannot be used for ranging.

Section 2.1.1.3.1 "In addition, when using an SBAS satellite for ranging, the equipment shall not mistake one SBAS satellite for another due to cross-correlation during acquisition or reacquisition. An acceptable means of preventing cross-correlation effects during acquisition is to reject SBAS satellite ranging data if there is a 200 km separation between the satellite positions derived from most recent almanac (received within 15 minutes) and the broadcast ephemerides."



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This verification is implemented by the majority of TSO/ETSO certified receivers whatever the availability of the ranging function, this optional behaviour has therefore become the baseline.

The EGNOS SBAS system does not provide the GEO ranging function, but nevertheless broadcasts nominally consistent information in the MT9 and MT17 messages. However, a number of MT9 and MT17 incoherency greater than 200 km, together with delays in the MT17 broadcast for more than 300 seconds and situations where the accuracy of the geostationary position greater than 150 km have been identified.

- MT9 MT17 incoherency: Most TSO certified receivers implement the MT9-MT17 coherency check regardless of whether the GEO ranging is enabled or not. This implies that at the GEO acquisition phase, most TSO certified receivers do not use the SBAS corrections broadcast by the GEO in the case that the GEO positions broadcast in MT9 and MT17 differ more than 200km.
- MT17 almanac data delayed (exceeding 15 minutes): If the almanac in MT17 is not received with useful data within the last 15 minutes, some receivers may not use the GEO corrections (not able to perform the MT9-MT17 cross-check to validate GEO corrections before using them), hence discarding the SBAS corrections from that GEO.
- MT17 inaccuracy (error larger than the ones specified in SARPS 3.5.7.1.4): Most TSO certified receivers may experience slight delays in GEO acquisition and re-acquisition, that would have a minor impact on the service recovery time after a SIS outage or loss of GEO tracking.

The following Figure provides the occurrence statistics of the different events during the period from January to June 2011.

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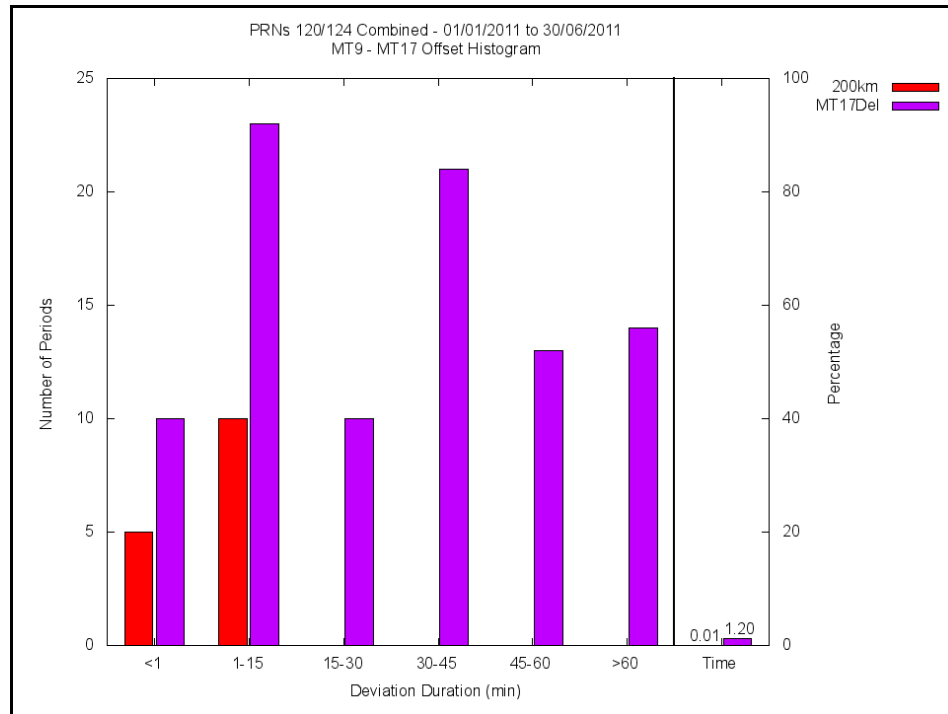


Figure 1: Distribution of MT9-MT17 issues periods– PRN 120_124 from January to June 2011

As can be observed, the percentage of time during which both GEOs were affected at the same time by the different MT9-MT17 issues (MT9-17 incoherency is quasi null and MT17 almanac data delays is 1.20% of the time) represents a low percentage of the time.

The values mentioned above will be refined with results obtained from future observations.

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2 POTENTIAL IMPACT ON THE EGNOS SERVICE

The potential impact of the MT9-MT17 incoherency ranges from a null impact for those receivers not performing the cross-correlation check in the GEOs, to a reduced SBAS availability and continuity, in case both geostationary satellites present a simultaneous discrepancy between the contents of MT9 and MT17, for those receivers implementing the check.

Observation shows that in the majority of cases, the occurrence of the 200 km incoherency between MT9 and MT17 happens only on one operational EGNOS GEO. Therefore the service will remain available through the second Operational EGNOS GEO (except in the case of a permanent MT9/MT17 incoherency on PRN124, which is detailed at the end of this section).

Based on procedures managed by the air navigation service provider (EGNOS Service Provider ESSP), an operational workaround (OWA) was put in place in December 2010 to recover from the occurrence of a lasting MT9/MT17 incoherency situation. However, during the last months, the high inclination¹ of the ARTEMIS (PRN 124) geostationary satellite (which represents the major driver of the MT9-MT17 issue behaviour of PRN124) has made the Operational Work Around less useful.

The impact of this inclination is such that actual satellite coordinate variations throughout the day cannot be accommodated in the coding ranges of ephemeris in MT9 and almanac in MT17 thus leading to a quasi permanent MT9/MT17 incoherency in PRN124 (Artemis GEO).

Depending on some receiver implementations, there could be also an impact in availability and continuity if the information broadcast in MT17 is delayed for both GEOs during more than 15 minutes.

The following tables presents an initial assessment of the MT9-MT17 issues on the continuity of service (last column) that could be experienced by certified user receivers (because of the different implementation of the MT9/MT17 check). The impact is limited to some receivers and is of the same order of magnitude as the continuity performance published in the SoL Service Definition Document.

This continuity assessment is conducted on the basis of EGNOS data collected over six months (January to June 2011) during which the OWA has been implemented. It is to be noted that, since the mean exposure time before implementing the OWA solution will be variable depending on the time of occurrence of the MT9-MT17 discrepancy, statistics established over a longer time frame may vary.

¹ ARTEMIS satellite (GEO PRN124) was launched in 2001 and positioned on an inclined orbit. This inclination has increased gradually ever since to reach around 9° today.

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MT9/MT17 Possible ² receiver implementations		Continuity impact ³ for APV1 users
MT9/MT17 Incoherency	MT17 delay	
<u>MT9/MT17 checked during signal acquisition / reacquisition</u> If incoherency above 200km is observed during acquisition/reacquisition, GEO signal not acquired.	MT17 delayed more than 15 min: acquisition/reacquisition delayed until MT17 received	None
	MT17 delayed more than 15 min imposes no delay in acquisition/reacquisition.	
<u>MT9/MT17 checked continuously</u> If incoherency above 200km is observed, the SBAS corrections will be rejected. If this happens on both GEOs, loss of continuity of the SBAS service can be considered.	MT17 delayed more than 15 min: SBAS corrections discarded	$2.7 \cdot 10^{-4} / 15$ sec
	If MT17 delayed more than 15 min, SBAS corrections not discarded	$2.4 \cdot 10^{-5} / 15$ sec
SBAS corrections broadcast not discarded due to MT9/MT17 check	N/A	None

The following table presents the prediction in term of continuity impact for APV-1 users with a permanent MT9/MT17 incoherency on PRN124. This situation is anticipated to last until the design change is implemented, or ARTEMIS is replaced, as explained underneath in section 3.

This situation with a quasi permanent MT9/MT17 incoherency on PRN 124 allows predicting the following continuity impact for APV-1 users

² This table gathers possible implementations that could be done on receivers, assuming three possibilities for the MT9/MT17 check (three rows) and the two possibilities with respect to a delay of MT17 longer than 15 minutes

³ This value of continuity impact should be added to the commitment values published in the Service Definition Document (SDD) for each user, and depending on its receiver behavior, inside the EGNOS Service Area.

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MT9/MT17 Incoherency	MT17 delay	
<u>MT9/MT17 checked during signal acquisition / reacquisition</u> If incoherency above 200km is observed during acquisition/reacquisition, GEO signal not acquired.	MT17 delayed more than 15 min: acquisition/reacquisition delayed until MT17 received	None
	MT17 delayed more than 15 min imposes no delay in acquisition/reacquisition.	
<u>MT9/MT17 checked continuously</u> If incoherency above 200km is observed, the SBAS corrections will be rejected. If this happens on both GEOs, loss of continuity of the SBAS service can be considered.	MT17 delayed more than 15 min: SBAS corrections discarded	10^{-3} / 15 sec
	If MT17 delayed more than 15 min, SBAS corrections not discarded	$1.5 \cdot 10^{-4}$ / 15 sec
SBAS corrections broadcast not discarded due to MT9/MT17 check	N/A	None

Finally, the inaccuracy of the GEO position provided by MT9 and/or MT17 could delay the acquisition or reacquisition of the GEO by the receiver. The duration of this delay will depend on the specific acquisition mechanisms implemented by each receiver manufacturer.

Regarding the impact on availability, and based on the statistics of the period from January to June 2011 shown above, it represents only 1.20% of the time (maximum impact expected for those receivers which consider the MT17 delay, no impact for those receivers not affected by this check)⁴.

In summary, the ICAO SARPs and MOPS requirements as currently existing leave leeway for different interpretations by service providers and receiver manufacturers and create an interoperability issue. Depending on the implementation selected, the overall impact on service may therefore vary significantly.

⁴ This value of availability should be subtracted from the commitment values published in the Service Definition Document (SDD) for each user with a receiver which consider the MT17 delay inside the EGNOS Service Area.

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3 WAY FORWARD

Three action lines are implemented in parallel, with different timescales:

1. The short term: Operation Work Around (OWA) is now less effective in front of the cause of MT9/MT17 incoherency on PRN124 detailed above.

The two remaining way forwards are closely managed by EC and ESSP.

2. The medium term: design change

A design change is to be implemented so that MT9/MT17 incoherency situations and MT17 refresh issues are not encountered anymore. However the non compliance to the ICAO SARPS accuracy requirement for MT17 will remain at this stage since it is partly linked to the inability of the current standards to ensure such compliance for ageing GEO satellite (ARTEMIS in EGNOS case). This change is expected to be ready by the first quarter of 2012.

3. The long term: evolution of the standards

The objective is to ensure an end to end coherent interpretation and implementation of the standards, currently considered as the root cause of the MT9/MT17 issue for EGNOS.

The first step of this evolution i.e. to identify the ICAO SBAS SARPS modifications that would be required in order to mandate consistency checks between MT9 and MT17 information including relaxing accuracy requirement and resolving de facto the remaining non compliance, has started.

Those modifications will be backward compatible, consistent with the planned MOPS changes and planned within a similar timeframe.

This evolution will take a rather long time due to the normal standards lifecycle.



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CONTACT US

Should you have any question related to this Service Notice or EGNOS Service Provision, please, contact Egnos-helpdesk@essp-sas.eu

For more information about EGNOS Service Provision, please, visit ESSP website at www.essp-sas.eu and user support website at <http://egnos-user-support.essp-sas.eu>