REPORT & SUPPORT MATERIAL RESULTS FOR LOCAL AREA DEMONSTRATION 5

METIS

D20-LAD-5

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## Summary Sheet

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1 INTRODUCTION

1.1 SCOPE AND PURPOSE OF THE DOCUMENT
Chapter 3 describes the Assembly Integration and Test phase; This document reports the results of the demonstration campaign that validates the demonstrator and the associated applications developed during the METIS Local Area Demonstration 5 (LAD 5) dealing with use of GNSS (EGNOS) in Rail domain/application for Tracking and Tracing of wagons and locomotives.

1.2 APPLICABILITY
This document is applicable to the Activity C/WP4150 Local Demonstration in Rail Wagon Fleet Localization in Turkey.
It provides the results of the demonstration campaign.

1.3 DOCUMENT OVERVIEW
The document is organised in the following chapters and contents:
Chapter 1 and 2 contains the introduction and methodology;
Chapter 3 describes the Assembly Integration and Test phase;
Chapter 4 describes the demonstration campaign preparation;
Chapter 5 reports the demonstration execution and result analysis;
Chapter 7 summarises the main results of the LAD 5;
Chapter 7 gives the conclusions.

1.4 LIST OF REFERENCES
The following documents have been used as references:

1.4.1 Applicable Documents

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1.5 Abbreviations

A

AIT Assembly Integration and Test

C

COTS Commercial Off-The-Shelf

E

EGNOS European Geostationary Overlay System

GPS Global Positioning System

G

GSA GNSS Supervisory Authority

COTS Commercial Off-The-Shelf

GUI Graphical User Interface

H

HDOP Horizontal Dilution Of Precision

HTTP Hypertext Transfer Protocol

HTTPS Secure HTTP

HPL Horizontal Protection Level
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### Abbreviations

| L | Local Area-Demonstration (METIS) |
| M | Mobile Unit |
| O | Original Equipment Manufacturer/Manufacturing |
| R | Ranging and Integrity Monitoring Station |
| S | Service Centre |
| SC | Statement of Work |
| SSL | Secure Socket Layer |
| U | Coordinated Universal Time (Temps Universel Coordonné) |
| V | Vertical Protection Level |
| W | Wide-Area Demonstration (METIS) |
| WP | Work Package |
2 METHODODOLOGY

The MU used in this demonstration is identical to the one of LADs 1/4 (operational constraints change with respect to the maritime LADs, due to the possibility to have frequent external power unavailability conditions, locomotives power off - according to the TCDD requirements).

For this reason, no stress tests are reported in this document (tests have been run just to prove nominal functioning of the device).

Next figure shows the EGNOS performance form the EGNOS OPERATIONS USER Support Website.

Figure 1 EGNOS service availability in the area
3 DEMONSTRATION EXECUTION

3.1 EGNOS-SUPPORT INVOLVEMENT

For the EGNOS performances, the EGNOS OPERATIONS USER Support Website available at www.asqf-gnss.com has been used, where information on EGNOS performances are included.

3.2 RUNNING PHASE

The LAD 5 started on 15 September 2008 and ended on 12 November 2008, for longer duration with respect to the one initially planed.

The running phase was characterised by the repetitive tracking of a train locomotive\(^1\), during its nominal tours in the country (a locomotive moving along rail tracks in the East part of the country - for EGNOS service coverage reasons - has been selected).

Next figure present one of the paths performed by the locomotive.

\[\text{Figure 2 Path followed by the train in the period 15/9/2008 – 20/10/2008}\]

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\(^1\) Due to a specific request of TCDD to have the demonstration running for a long time and the need of the demonstration to have it running over a path in the East part of the Turkish territory, it has been decided (in agreement with the TCDD) to install the MU on an operational locomotive performing normal operation in the East part of the country.
3.3 DATA COLLECTION
The ELSACOM MU was operated from 15 September, 2008 15:19:20 UTC to 12 November 08:23:29 UTC. A total of 1016 messages were received from Telespazio SC.

3.4 DATA ANALYSIS
As done in other demonstrations, the main goal of the data analysis activity is to validate the applicability of the proprietary algorithms used in the Telespazio Service Platform to calculate HPL values.

As done for LAD1, additional analysis has been done to consider the geographical distribution of the HPL. The rationale of this analysis relies on the fact that the path of demonstration is located in a zone where the EGNOS performance change very quickly (border of the service coverage area).

The following analyses have been done

GCA field analysis:
- HDOP values and statistical distribution
- Number of satellite in view

SBAS field analysis:
- Testmode enabled (Yes/No)
- SBAS system detected (EGNOS/other)

Protection level analysis:
- Percentage of HPL calculation
- HPL statistical distribution
- HPL geographical distribution.

HPL statistical distribution and geographical distribution have been purposely done for the LADs in Turkey, as the demonstrations were running in zones at the border of the EGNOS service area.

For the remaining analyses, the concepts already used for the WAD3 have been applied.

3.4.1 HDOP values and statistical distribution
The HDOP parameter is linked to the number of satellites in view and their relative geometry. Its value gives an immediate feedback about the quality of the positioning data.

Next figure shows HDOP values; HDOP average value is 1,29 with some variations.

In four cases, the HDOP is greater than 4.
In three cases the spikes is linked with a low (5) number of satellites in view.

**Figure 3 HDOP values**

### 3.4.2 Number of satellite in view

The number of satellites in view is between 5 and 12, with an average number of 8.
3.4.3 SBAS field analysis

The analysis is related on the Testmode enabled (Yes/No) and SBAS system datafields, in the receiver output.

The Testmode shall be enabled due to the present EGNOS operational status. The datafield in the receiver output can be:

- 0 = Disabled
- 1 = Enabled Integrity
- 3 = Enabled Testmode.

During this demo all messages turn out to be Testmode enabled (3)
The SBAS system datafield in the receiver output can be:

- -1 or 255 = Unknown;
- 0 = WAAS (Wide Area Augmentation System – the U.S. domestic augmentation system);
- 1 = EGNOS;
- 16 = GPS.

Hereafter the percentages of the detected values are reported:

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<td>0.49%</td>
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<tr>
<td>WAAS</td>
<td>0</td>
<td>0.00%</td>
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<td>EGNOS</td>
<td>1011</td>
<td>99.51%</td>
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<tr>
<td>Total messages</td>
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<td>100.00%</td>
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3.4.4 Protection Level analysis

Over a total of 1016 messages, HPL calculation was not done for 156 messages. The relevant statistics is hereafter reported:
Figure 5 Percentage of HPL calculation

Next figure presents the distribution of the HPL values. Except for a few cases, the typical value is in the range of 8-12 meters.

Figure 6 HPL statistical distribution

Next figure presents the distribution of the HPL values wrt longitude and latitude.
No specific correlation has been found between the value of the HPL and the geographical position, in the area under observation.

Next figure shows the path of the demonstration reported on the EGNOS performance map (source: EGNOS OPERATIONS USER Support Website).
4 MAIN RESULTS

4.1 MOBILE UNIT

The Mobile Unit used in this demonstration is the ELTRACK-G, identical to the one used for LAD 1.

The ELTRACK-G was installed in the power area of the TCDD E 43 042 train, in service between ANKARA and ISTANBUL.

The installation was complex due to an erroneous 220AC voltage source, the problem was solved thanks to the TCDD personnel.

Figure 8 The E 43 042 TCDD locomotive
Figure 9 ELTRACK-G installed in the power area

The GNSS/GLOBALSTAR antenna was installed on the train roof; RF cables run outside using a sealed door access to the roof (cables were protected through a flexible steel cover).

Figure 10 Antenna installed on the train roof
4.2 SERVICES

The demonstrations were purposely conceived to give the opportunity to the user to become familiar with the new technology and services, and provide useful feedback and new ideas for new services.

In particular the developed services are focused on the elaboration of integrity (horizontal protection level)/use of EGNOS CS, and as in line with the assumptions and considerations done in the GNSS Regional Plan of METIS Activity A.

Moreover for this demo, the added value of EGNOS for rail applications in analysed.

The following snapshots show the visualization of position and the relevant horizontal protection level (rail tracks are visualised).
4.3 EGNOS ASSISTED TECHNOLOGY

As for LAD1, this demonstration has allowed to extensively prove and stress the EGNOS-assisted function for EGNOS integrity use in land applications.

The function performs Protection Level calculation (MOPS – Minimum Operational Performance Standards) and using a proprietary solution for land conditions (not APV). It is ready to use EDAS (EGNOS CS).

Two interesting analyses have been done in this demonstration:
The first considers the geographical location, in areas with different EGNOS service performances (results have been presented before).

The second applies the percentile method (also used for civil aviation). Here after the results of such analysis: in 99% of the cases, the HPL is less than 33.08 m, the standard deviation is 5.9 m.

<table>
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<th></th>
<th>99%</th>
<th>95%</th>
<th>50%</th>
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### 4.4 User Feedbacks

As already explained, the demonstration has been focused on the use of the EGNOS CS, and possible added value services that can be built on it.

The main purpose has been to take profit of this demonstration to support the work on the GNSS Regional Plan (Activity A).

EGNOS CS is the service based on the CDDS (EGNOS MRD), and implemented with EDAS. Downstream Service Providers can implement solutions to create different types of value added services. The service architecture is based on a connection (via Frame Relay or MPLS) between the downstream Service Providers and EDAS to get EGNOS data, for delivering it and/or products built on it.

Turksat has provided interesting inputs that have been duly taken into account in the elaboration of the CBA of the GNSS Regional Plan.

It shall be considered that in the GNSS Regional Plan proposed by METIS, Turkey has been considered the country where rail freight is among priority applications in the considered time frame (source *Turkish Transport News July 2008*):

- TCDD is presently making huge investments for the enhancement of the rail sector specifically in the freight transportation (infrastructures, logistics platforms/"logistic villages" in most of the important areas of the country, structures and connections for intermodality)
- Such developments will enhance present services and create new services, in line with the EU standards (considering the fact that the rail network is strategically the prolongation of main trans-EU corridors in the MEDA area). Use of advanced technologies, as in line with the EU trends, is also foreseen.

With these investments the purpose of the Turkish railways is to increase the freight traffic of 40%.

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2 Istanbul will host the biggest one
4.5 **Promotion Campaign**

Following the conclusion of three demonstrations in Turkey (LAD 1, 4 and 5) implementing the use of EGNOS for maritime and rail applications, a promotion event was organised drawing the attention on opportunities and benefits of GNSS technologies and services in transport domains, with EGNOS today and to prepare the market for Galileo.

The event was held in Istanbul on the 29.01.2009, hosted by Turksat.

The event also gave the occasion to present the final GNSS Regional Plan elaborated by METIS project, following the workshop in Cairo last October 2008.

The event was chaired by the EC and DGAIDCO, and 7 National Coordinators of the MEDA countries attended the event, as well as stakeholders from the Civil Aviation and freight sectors.

The focus of the event was the EGNOS CS, its use and business opportunities in land applications and personal mobility.

4.6 **Inputs for Activity A and B**

As already mentioned, Turksat involved in the demonstration has been invited to:

- Fill the user needs questionnaire for the elaboration of the GNSS Regional Plan
- Provide inputs for the elaboration of the business models for the CBA
- Provide feedbacks following the final GNSS Regional Plan workshop.

The demonstration results have been used during the Final GNSS Regional Plan workshop to concretely show the use of EGNOS. They will be used in all METIS foreseen promotion events.

A leaflet has been produced, to contribute to the promotion material of the project and to be distributed/shown during the Istanbul promotion event.

4.7 **Recommendations**

As for LAD 1, the main recommendation is to perform pre-operative demonstrations:

- Using EDAS
- Involving a significant number of Mobile Units
- Refining the assumptions done in the GNSS Regional Plan CBA, to elaborate customised assumptions for Turkey (cost evaluation based on device and telecommunication costs, cost distribution, business model).
5 CONCLUSIONS & LESSONS LEARNT

Rail freight is a promising market for Turkey and it has been considered a priority application for EGNOS services in the country.

This demonstration is the first step to show the possible use of EGNOS CS in the maritime sector.

Possible next steps are:

- Use of operational EDAS
- Perform large-scale demonstrations in Turkey and in other countries
- Refining the assumptions done in the GNSS Regional Plan CBA, to elaborate customised assumptions for each MEDA country (cost evaluation based on device and telecommunication costs, cost distribution, business model).